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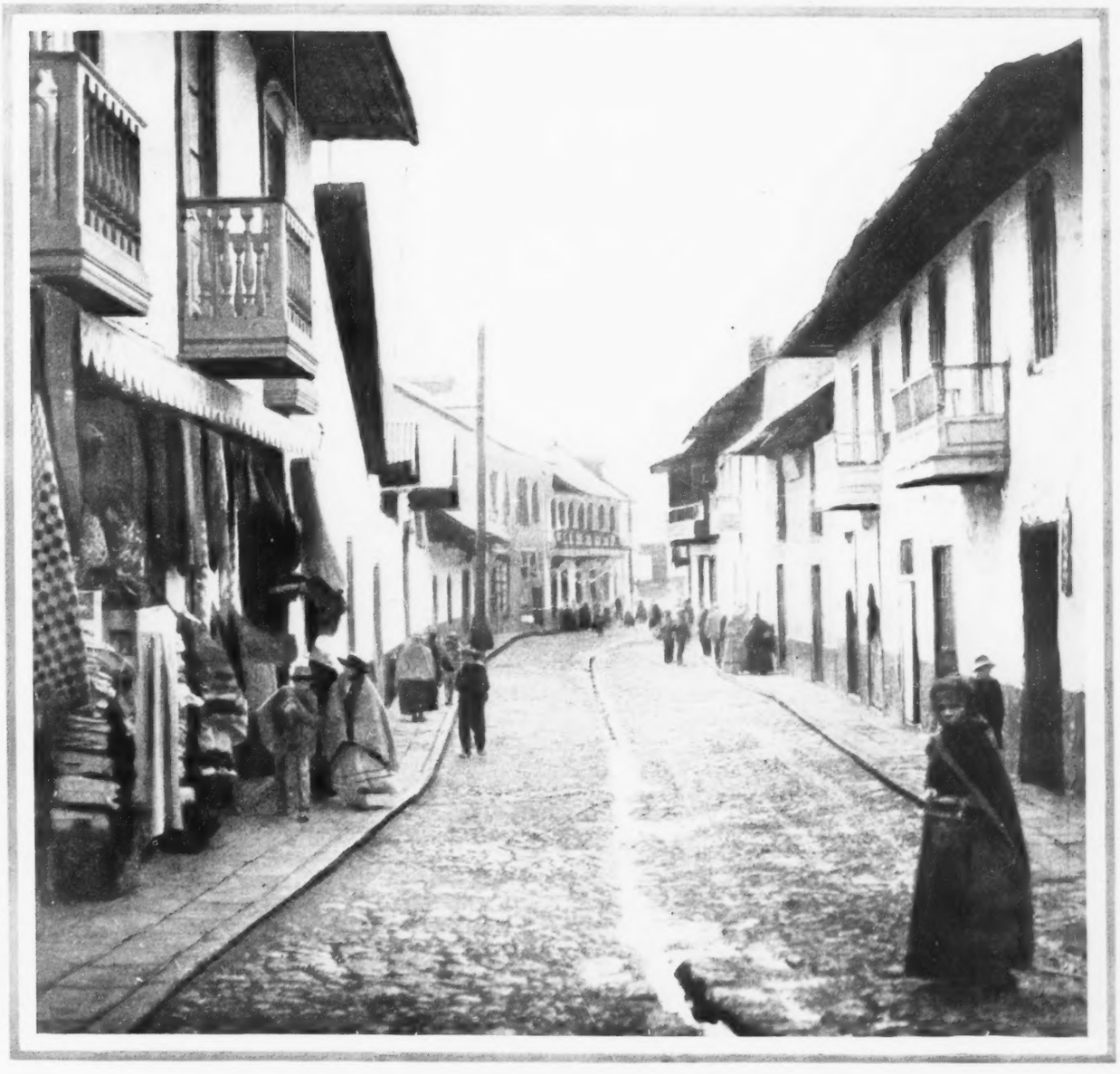

Hydrogen Reduction of Bolivian Tin Concentrate, by C. G. Fink and C. L. Mantell

The "Why" of Flotation, by Professor A. M. Gaudin

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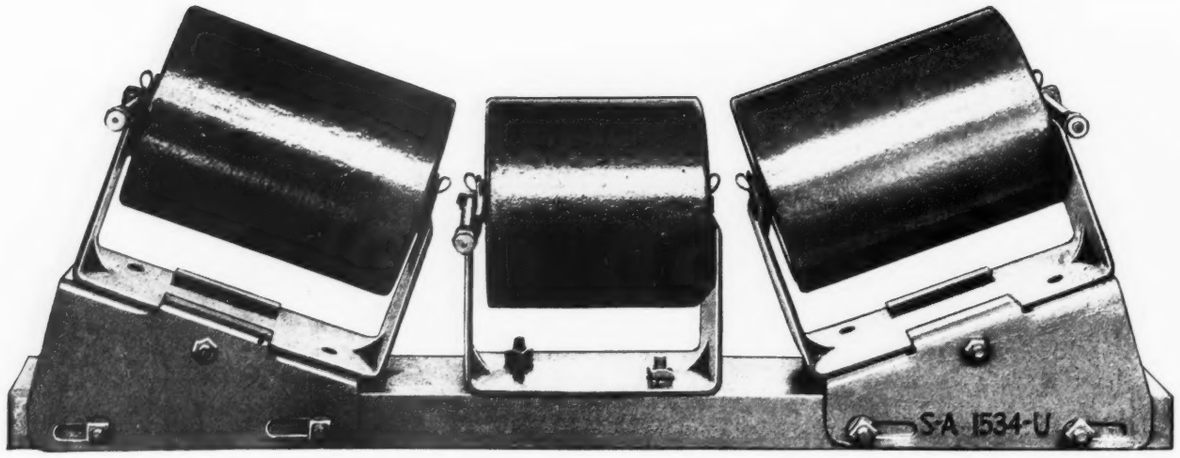

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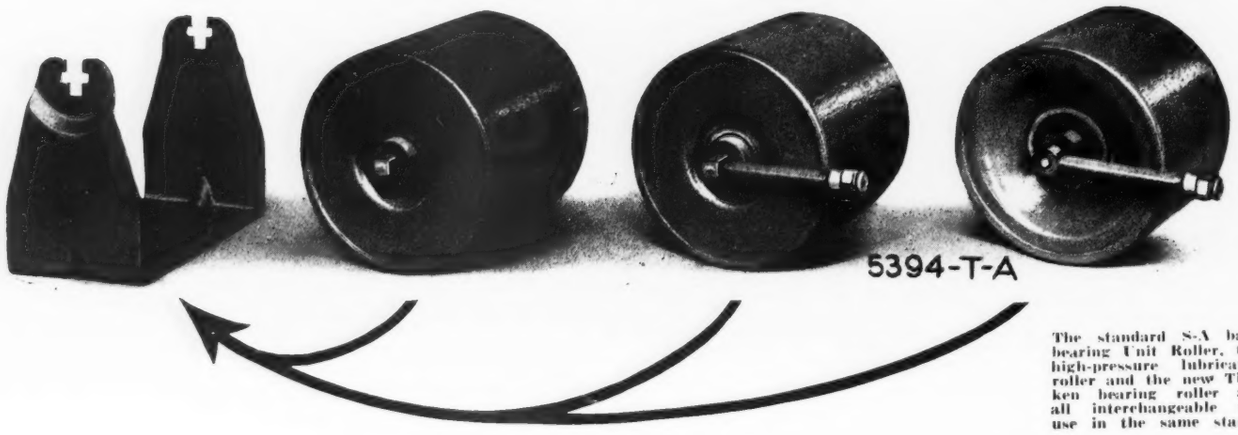

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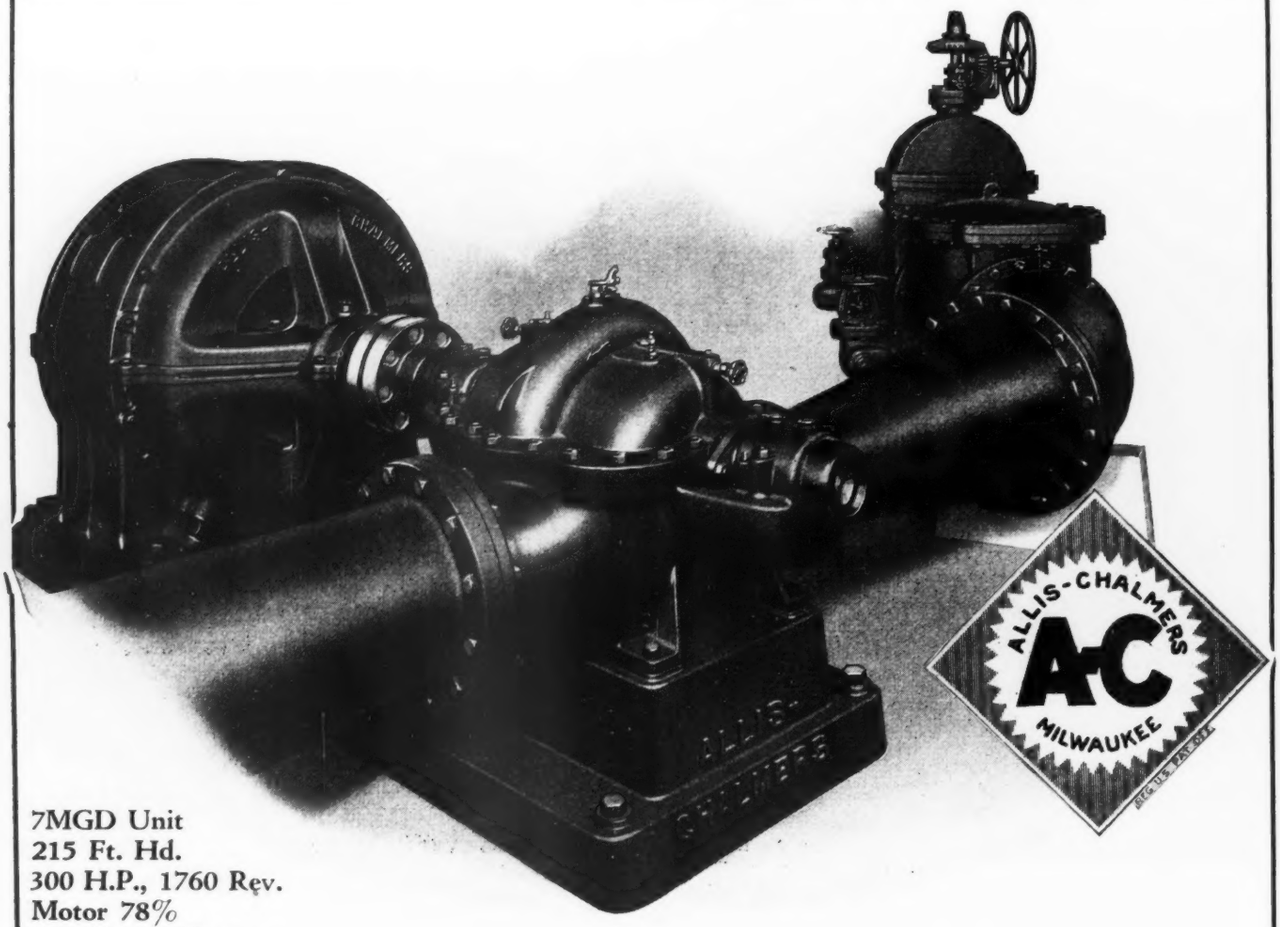

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ENGINEERING AND
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McGraw-Hill Publishing Company, Inc.
JAMES H. MCGRAW, *President*

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Editor

VOLUME 124 — *New York, December 31, 1927* — NUMBER 27

Prompt Co-operation With Census Bureau a Duty

THE Federal government commences the New Year with the task of surveying the operations of American industry during the previous twelve months. Until 1919, an industrial census was taken every five years, but at the end of 1921 a biennial census was instituted—in line with the intensive commercial expansion and progress made since the war.

Avoidance of waste and the goal of efficient standardization are helped to a considerable extent by the availability of complete data as to production and distribution; but such information, to be of value, must be up to date. In the past, the delays occurring in the preparation of the census have resulted in a date of issuance indicating that most of its potential value was lost. A record for timeliness is hoped to be established in the census for 1926-27, which will be of inestimable benefit to all concerned; but nothing can be done without the prompt and helpful co-operation of manufacturers. Questionnaires should be attended to and returned without delay. The functioning of the Census Bureau will be seriously retarded by procrastination, and American industry will be the loser.

The American Institute, and the Encouragement of the Useful Arts

ANY effort to bridge the gulf between science and industry is worthy of consideration. If the American Institute had nothing more to its credit than the part it played in the reorganization of the patent laws and the establishment of the Patent Office during the early days of patenting in the United States, it would merit the support of all who are concerned with the trend of national progress. This single reference to constructive work indicates that it can boast of a maturity deserving of respect. It was founded in 1812, "for the encouragement of the useful arts," at a time when the domestic manufacturing industries needed encouragement and support. In 1828 it became the American Institute of the City of New York. In the meantime its activities have been many and varied. Recently, fellowships were granted to firms who were members and who received awards of merit from the Institute fifty or more years ago. Among this list may be noted the names of the American Brass Company, E. & T. Fairbanks & Company, the Ingersoll-Rand Company and the Worthington Pump Company. As a record of contemporary industrial development during its first hundred years of activity it will publish in 1928 a volume entitled "A Century of Industrial Progress," the section on mines and mining in which will be contributed by Dr. H. Foster Bain, secretary of the American Institute of Mining and Metallurgical Engineers.

The American Institute has had an honorable though not spectacular career. It has done and, it is hoped, will continue to do, good work in aiding and encouraging invention, and in bringing together those two essential elements without which no nation can expand in peace and prosperity—science and industry; but we were frankly disappointed at the program presented at a recent luncheon meeting, at which the scheduled speakers, including Mr. Maurice Holland, director of the Division of Engineering and Industrial Research of the National Research Council, calmly announced the imminent extinction of the independent inventor, contemptuously termed the "garret genius," who, it was forecast, should he persist in giving rein to creative ability, would have to seek employment in a research laboratory.

Excellent work has been done by co-ordinated and group endeavor in the field of inventive activity, and the staffs of many large corporations are to be congratulated on the results; but the same tribute, in far greater degree, is due to the lone scientist and the too-oft discouraged inventor, who works frugally and who cannot enlist the aid of the expert legal assistance available at the beck and call of the members of subsidized research organizations, some of whom would doubtless welcome the extinction of that competitive creative effort foreshadowed by Mr. Holland.

Individual initiative and zeal; individual faith in the outcome; the zest of personal achievement—world progress owes its amazing advance in recent years almost entirely to these factors. It is neither logical nor just to discourage or underrate them.

Aiding the Government in Prosecuting Mining Stock Frauds

ONE of the reasons that great difficulty is experienced in curbing the activities or ultimately convicting vendors of fraudulent mining stocks is the fact that government officials and other agencies seldom have had the help of mining engineers with expert knowledge and high professional standing. The crux of the fraud is that the promoter of a stock-selling campaign overcapitalizes his company; so that, even if the property may have intrinsic value, the shares are worth, even on a speculative basis, only a small fraction of the price at which the promoter sells them. He is able to employ—to the disgust of reputable members of the mining profession, be it said—engineers and geologists who are shrewd if unscrupulous, to make favorable reports on which to base deceptive but glittering claims.

To combat successfully these activities, officials charged

with the protection of the public and the prosecution of malefactors should have the aid and advice of competent engineers. Men are needed who can discern the technical sham, and who have sufficient prestige to go into court and give convincing testimony in the capacity of expert witnesses. That the prosecution has seldom retained such men can be accounted for in many ways. Probably the difficulty of getting adequate appropriations to compensate high-grade expert witnesses has been one obstacle. Another, perhaps, is the disinclination of the reputable engineer to engage in such work. It is almost impossible to get one member of the medical profession to testify against another, no matter how flagrant the charge; and a lawyer, generally speaking, places high in his code of "ethics" the protection of a fellow lawyer, irrespective of right or wrong. Possibly some such attitude has been a factor in the failure of mining engineers to assist directly in the prosecution of fake promoters, in schemes wherein an engineer is involved; and the successful stock jobber usually has one or more such engineers in his employ.

Such an attitude cannot be justified either by doctors, lawyers, engineers, or any other group of professional men, if they accept any responsibility whatever for the public welfare and the good of society at large. Recently, the federal government has been able to retain the services of several mining engineers of high standing, to assist in a professional capacity in the prosecution of two notorious fraudulent mining-stock promoters, who thus far have been able to defy the law. *Engineering and Mining Journal* believes that lofty motives actuated these engineers in the acceptance of a difficult task; that they are justified in accepting a commission to perform a distinct service to the public, to the profession of mining engineering, and to the entire mining industry.

Where Big Resources Are Necessary

MINING in districts far removed from what is known as civilization must, to be successful, be carried on by large, well-financed organizations able to cope with unusual conditions. Had a small company undertaken to mine and treat the Chuquicamata orebody, in Chile, at a rate of 100 or even 500 tons a day, failure would almost certainly have resulted. The great Katanga property, in central Africa, has been struggling along with a small production for twenty years, even though treating a 15 per cent copper ore; only recently, with the planned expansions, has it given any immediate promise of financial return to investors.

The experience of a small company operating in Alaska is just at hand, where apparently due thought was not given to the distance from a supply of labor, nor to the short season in which it is possible to work. If a company had, say, four million cubic yards of dredging ground in California, averaging 60c. a yard in gold, it would not be out of reason to figure that the ground could be worked over at the rate of 50,000 yards a month, or 600,000 yards a year, with an annual profit of a quarter of a million dollars or more. Investors would be attracted by such an opportunity. But consider that the property is in Alaska. The company mentioned had a crew ready to sail from Spokane on the first of June, but the date of departure of the steamer was repeatedly postponed; finally, the steamer was hung up in the ice in Bering Sea and did not land at Nome until the latter part of June. It was the tenth of July before the crew reached the property. It took seventeen days to get the company's dredge out of winter quarters. Then it was found that the pay streak, which was just above bedrock, was still frozen; in fact, for this reason, operations throughout the summer had to be confined to shallow ground, so the recovery was 35c. per yard instead of 60c. as expected. "On the tenth day of October our operation ceased, due to the extremely cold weather which froze everything up tight," says the report. The dredge operated 64 days, and the gold recovered amounted to $28,500. And the report adds: "It must be remembered that this summer was a summer that was sixty days backward and in Alaska there was really no summer." Under more favorable conditions a satisfactory profit would perhaps have been realized, but this experience is good evidence of the difficulties small companies operating in distant places must be prepared to meet.

Metal or Wood as a Roofing Material

THE lumber trade recently engaged in a nation-wide campaign of advocacy for the extended use of its products, the advertising matter intimating that the country possessed "plenty of wood for all future needs." This and similar statements have brought a sharp rebuke from the chief of the Forest Service of the U. S. Department of Agriculture, Col. W. B. Greeley, who maintains that "our timber supply is being used up much faster than it is being replaced by new growth, and that most of the lumber still comes from the diminishing virgin forests."

Reforestation is practicable, but will the lumber industry shoulder the responsibility and accept the task? "The United States," affirms Colonel Greeley, "will certainly have to face a period of diminished domestic supply of timber." Intensive reforestation is the only remedy. The supply is by no means inexhaustible, and the forest lands are not self-sustaining.

Everyone is aware of the unsatisfactory nature of the ordinary wooden shingle as a roofing material. The public has been well educated, by an advertising campaign, on the subject of leaky water pipes, made of rustable metal, but inadequate attention has been drawn to the damage done by leaky roofs. Yet it should be insisted upon that the wooden shingle roof is wholly unsatisfactory for several reasons, particularly because of the need for repair. Finally, when the inevitable can no longer be postponed, and it has to be replaced, the mess and disorganization is appalling.

Periodically, a fire disaster of considerable magnitude brings home to householders the grave danger of wooden shingles as roofing material. An all-too-brief campaign in favor of non-flammable roofing attracts public attention; laws are passed prohibiting the use of wood for this purpose; but too frequently they are rescinded or fall into desuetude at the direct or indirect instigation of the lumber interests, who see, in the continuous replacement of wooden shingles, a never ending source of revenue. "There is plenty of wood for all future needs," they say; and its use as wooden shingles is certainly the best way to waste it and so to hasten the time of diminished domestic supply of which Colonel Greeley warns us.

What more aggressive steps can be taken to equalize the retail prices of non-flammable and wooden roofing materials, or to show, for instance, that one metallic roof is cheaper than an indefinite number of wooden roofs,

frequently under repair? Or, rather, what pressure can be brought to bear to insist that the continued use of flammable material in this connection constitutes a grave menace to the community permitting it? Has every means been exhausted to persuade the householder and the housebuilder as to the merits of metallic roofing—to allow the citizen of moderate means to pay for it on the installment plan? Eventually, a non-flammable material must oust wood for this purpose. Why not a vigorous propaganda to bring this about now?

The Problem of Standardizing Technical Nomenclature

WORDS are, or should be, used as tools of precision; but confusion may arise, and good tools of this type may become blunted and useless, if the selection is indiscriminate or made without regard to the fact that most processing methods have a common scientific basis. Thus it often happens that, when an old method is applied in a new field, a fresh but strictly local nomenclature is adopted. The average engineer, who is more concerned with the application of basic and proved principles than in the novelty of their extension, finds difficulty in following a description of a new application of well-known fundamentals. In editing an article on electrolytic zinc recovery recently we found that the author spoke of the primary dissolving phase of a hydrometallurgical operation, *by agitation,* as "leaching." This made the description intelligible only to zinc metallurgists accustomed to the use of the term thus. *Engineering and Mining Journal* believes, however, that much good can be done by a frank discussion and the adoption of precise and correct terms to describe a basic operation.

The word "leach" is derived from the Anglo-Saxon word "leccan," meaning to wet or moisten. This is the primary definition given by Webster. The second meaning is given as "To percolate (a liquid) through something, as ashes"; and a third definition is similar: "To subject to the action of percolating water or other liquid in order to remove the soluble parts; to lixiviate; as to leach ashes or coffee"; and the fourth and last meaning given by Webster is little different: "to dissolve out by the action of a percolating liquid; often used with *out*; as to leach out alkali from ashes." It is plain from these definitions that percolation is considered an essential part of leaching.

As already pointed out in these columns, "percolation" infers the passage of a liquid through the interstices between the particles of any material permitting it. "Leaching" is the process of extracting soluble matter by percolation. "Lixiviation" is analogous to "leaching." Percolation occurs during filtration.

The act of leaching results in two separate products—an enriched solution and an impoverished residue of undissolved matter. The act of agitation may result merely in keeping solid matter in suspension, in blending or mixing or wetting, or chemical action, or crystallization, or simple dissolution. If agitation is adopted to promote the dissolving of a valuable metal or mineral, it must be followed by a separating and leaching process, to free the gangue from the resultant enriched solution, and to dissolve any unattacked metal or compound, or crystallized or adsorbed compound in the mass, the extraction of which is desired. Inasmuch as agitation must be practiced on a comparatively finely ground material, the subsequent operation of filtration must usually be performed by the aid of pressure or vacuum, involving the use of a machine, or filter. The simple act of complete leaching on the other hand, may necessitate only the utilization of gravity pressure of solvent through a mass of material at rest. In a mechanical sense, leaching achieves much more than agitation: it accomplishes dissolution, and, at the same time, a separation of the valueless from the valuable.

In chemical or wet chemico-metallurgical processes, the use of the word "filter" has been extended beyond its previously accepted scope. The simple separation of solid from liquid, such as occurs when a thickened flotation concentrate is filtered, should be termed "dewatering." The word "filtration" is being used more to cover the complex process of separating, so far as possible, solid from liquid by vacuum or pressure, removing the residual solution by wash, and at the same time leaching any recrystallized, absorbed, or undissolved matter by percolation with the solvent. At the Homestake plant the gold is leached from a sandy product in vats. The slime pulp is dewatered in presses, and the cakes are leached with cyanide solution and wash water. In this instance the filter press functions mainly as a convenient means of permitting satisfactorily percolation after dewatering has been accomplished.

Need for Stability in the Mining Industries

A FRANK ACKNOWLEDGMENT that unstable conditions are in evidence in some of the mining industries was made by Mr. Hoover at the recent convention of the American Mining Congress at Washington. The Secretary of Commerce spoke helpfully and hopefully; and the leaders of the industries in question may feel thankful that the position has been viewed by one government official at least in an impartial and unbiased manner. Upon the stability of the mining industries, Mr. Hoover maintained, rests in large part the stability of the whole country. If one examines the price levels of the important minerals, excepting perhaps anthracite and lead, it will be found, he continued, that, compared with pre-war prices, they are below the average of all commodities. Consequently, it is evident that the miner has just cause for complaint in that the price of his commodity is below the relative average price level of the commodities he must buy and the wages he must pay. Mr. Hoover showed, for instance, that, whereas the average cost of all commodities today is about 47 per cent above pre-war prices, copper is 21 per cent below.

This condition calls for remedial action; but official Washington as a whole provides scant encouragement for those who may hope for a more equitable return for their investment and labor, and less waste of national resources. The legal mind is apparently unanimous in its recommendations. The leaders in an industry that is suffering from lack of co-ordinated control can and should combine, one is told, provided that they do not combine in a form contrary to a law that makes effective combination impossible! The Sherman Act is shown to be capable of a fresh interpretation almost every day—a process described by the law-making experts with pride as "clarification." Never has interpretation of a law that has caused widespread unrest and dissatisfaction been so

sympathetic to business, one is told. The bogey of government management of industry is trotted out for all to see, despite the fact that the subject is introduced apropos of nothing at all. Everything the government places its hands upon is struck as with a blight, one orator has averred, forgetful of the capable functioning of the Post Office, the Patent Office, and other efficient federal departments. The slogan about individual reward for individual effort is worked to death, despite its irrelevance, for it lacks pertinence or application in any study of the present problem. The specter of state interference in the production and preparation of minerals is paraded to strike terror in the hearts of those who hope for logical co-operation on the part of the government in the solution of their marketing problems. No differentiation is made between a healthy competition in a race for technical superiority and an underhand competition in price shading. All forms of competition, according to one government spokesman, have been embodied in our laws as "the philosophy of human relationship." In another connection one is warned of the effects of interfering with the "free play of economic forces"—a fine phrase that may be used pro or con. "Industrial liberty" is a slogan adopted by one orator to infer that a member of an industry on the brink of bankruptcy should not be forced to co-operate against his will with the other members of that same industry in a concerted effort to secure a fair price for their product in a time of unparalled national prosperity.

With some opinions it is fruitless to argue. The best that can be hoped is that Mr. Hoover's grasp of fundamentals and keen humanitarian insight may influence others in Washington to realize that all is not well with the mining industries, and that co-operation and regulatory action may well provide a solution of a difficult problem and call a halt to national waste.

National Engineering and Techno-Industrial Museum

THE PROPOSAL to establish and endow a permanent exhibition of models illustrating the evolution of engineering equipment and techno-industrial processes is again to the fore. The fundamental idea has merit. As Dr. Michael I. Pupin has said: "Give the youth a chance to be thrilled by the achievements of past generations, and do not rely on books alone to produce this thrill." The mechanical fundamentals underlying modern industry will provide a groundwork for creative thought. Working models effectively illustrate the application of power to commerce, and carry the mind of the student by easy steps to an appreciation of the function and application of machines and the development of inventions. Mining methods, metallurgical and electrochemical processes—in a wide variety of form and application—offer unusual scope for depiction in miniature. Great Britain and Germany have such exhibitions, of easy access to the masses, of absorbing fascination to the young, and an education to all. Why has the United States lagged behind in this type of popular appeal to the mechanical instinct so widely distributed?

The National Museum of the Smithsonian Institution at Washington has the nucleus of an exhibition of this character, but it is small and incomplete. In 1922 the national engineering societies were asked to consider the subject of providing a museum of a size and comprehensiveness commensurate with engineering and techno-industrial advance in this country. A joint committee favored the idea, but the report issued stated that, given the site, the cost of the proposed building would be $4,500,000, with an additional $3,500,000 for endowment to bring in an annual income of $200,000, which would seem to be adequate for administration, maintenance, and the acquisition of new models, to supplement those presented. The committee decided that Washington should be the headquarters of such an exhibition, "to preserve the experimental and operating originals of epoch-making scientific, engineering, and industrial inventions and discoveries as a permanent record of great achievements." It recommended, moreover, that "There should be established in large centers of population of the United States, industrial museums of an educational type wherever local initiative manifests real interest in such undertaking and when substantial financial guarantees are assured for the foundation and endowment of such museums."

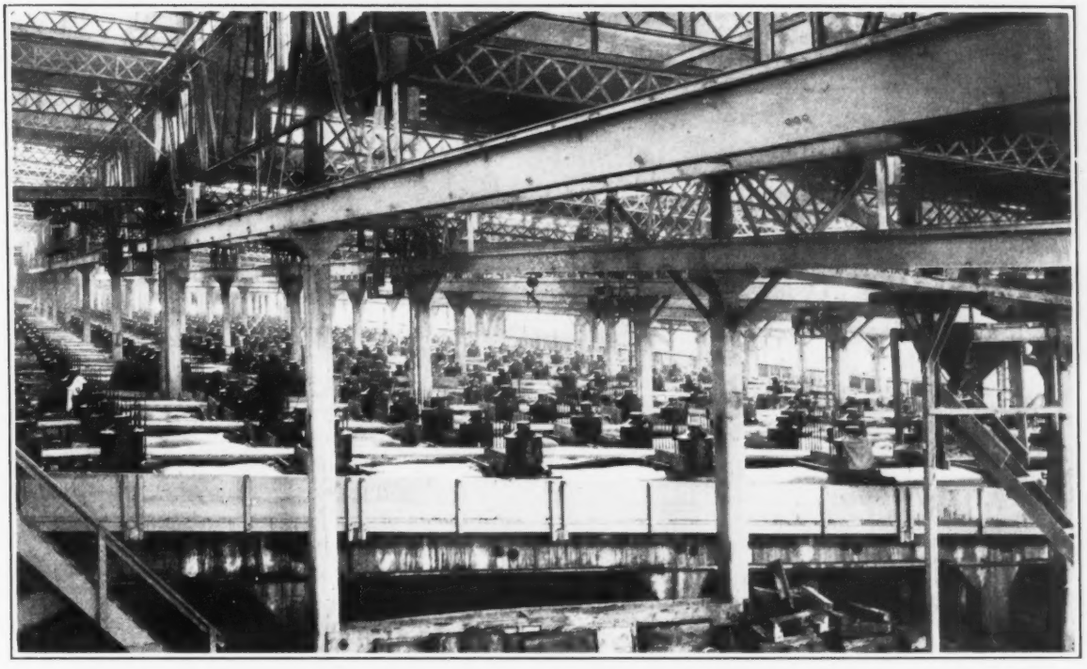
The proposals if put into effect would have involved lamentable waste of money. What possible reason can exist for the proposal to establish, at enormous expense, an exhibition of working models in a city such as Washington? A collection of this character may constitute a "museum" in which such models are "preserved," it is true, but its main purpose should be the encouragement of inspiration among the greatest number. And having spent $8,000,000 on the Washington collection, a large part of which will be absorbed by the cost of an imposing building, a rich gesture infers that any large city or center of population may repeat the investment, at its own expense. Greater New York and the surrounding industrial cities constitute in the aggregate a colossal center of population and industry. If the basic idea be meritorious, as it certainly is, the best and most complete collection should be in or near New York City—to be open to the largest permanent and transient population in the world—available for the recreation and the inspiration of millions of students, and the tens of thousands of operatives in near-by industrial plants. Other large centers of population should then follow suit. Granted that such an exhibition is needed in New York, however—where the engineering societies have their headquarters, by the way—what possible justification is there for another and similar collection at the national capital?

The Victoria & Albert and Munich museums are essentially practical, not political, in appeal. It is felt in some quarters that more of the money amassed in the form of large fortunes by mining investment and mining exploitation should be spent in an educational and inspirational project of this character, definitely connected with mining and metallurgical enterprise. The hazard that any appreciable proportion of such accumulations should be diverted for the provision of a "museum of preservation" at Washington draws prompt protest from those who believe that no adequate benefit would accrue thereby to the people of the United States as a whole.

Although metal-mining and milling operations, available to further peaceful advance or protection from warlike aggression, are illustrative of noise at its maximum, we are glad to add a postscript in support of a proposal now in concrete form—to establish an exhibition of this character in or near New York City, to be known as the Museum of the Peaceful Arts. A strong directorate, presided over by Dr. George F. Kunz, is announced, and further developments will be awaited with interest.

The "Why" of Flotation

By A. M. GAUDIN
Associate Professor of Metallurgical Research, University of Utah, Salt Lake City



Flotation floor in the Magna concentrator of the Utah Copper Company is the largest of its kind in the world

JUDGED by its accomplishments, flotation is, no doubt, the greatest single metallurgical improvement of the present century. Strangely enough, this progress has come about not so much as the result of an understanding of the fundamentals of the process, as of considerable testing of the cut-and-try variety on countless ore samples. As knowledge of the subject is advancing, progress by hazard is less and less productive; it is becoming increasingly necessary to understand the "why" of all the semi-mysterious doings connected with the working of flotation.

The main troubles of the milling man accustomed to gravity concentration have been of a mechanical nature, such as are inherent in the operation of belts, pipes, or machinery. The troubles of the flotation man, however, are largely microchemical; they frequently are beyond his sight even when aided by the microscope. Things just go "hay-wire" for a few hours or a few days; then readjust themselves without apparent reason. This is largely because flotation depends on the proper use of certain properties of matter generally considered as of insignificant magnitude, and the existence of which still is often questioned. It is necessary therefore, in order to understand the "why" of flotation, to attack the subject open-mindedly and to dismiss no possibility until it has been definitely proved to be unimportant.

Concentration processes other than flotation depend essentially for their operation on forces, such as the attraction of gravity, which act on the surface as well as on the interior of mineral grains. Flotation, on the other hand, depends essentially upon those forces which cause or prevent adherence of wetted mineral particles to gas bubbles, and therefore involves solely the surface of the mineral grains. Completely excluding the attraction of gravity from any part in flotation is, of course, not correct, inasmuch as the apparent mass of mineral particles, if large enough, will modify the sticking of these particles to gas bubbles. It would therefore appear that the attraction of gravity plays a minor part in flotation, except in connection with the floatability of the coarsest grains.

The surface forces that control flotation naturally belong to the general group known as molecular or atomic forces, and are the result of the structure of atoms and of the inner motions of their constituents such as electrons. The physicist tells us that matter is composed of very minute grains of electricity and of a lot of emptiness. That a chunk of steel is more than 99.99 per cent emptiness and the rest electricity is a somewhat startling fact, yet the evidence is generally considered satisfactory: our senses do not perceive this astonishing fact because they are not equipped to analyze minutely enough. Elements occur as atoms which are substan-

tially indivisible, orderly arrangements of grains of positive electricity (protons) and grains of negative electricity (electrons) in emptiness. Very rapid motion and orderly distribution of electrons around the positive nuclei characterize the structure of atoms and contribute to the formation of surrounding fields of atomic force whose symmetry depends upon the arrangement of the rotating electrons. Substances, compounds as well as elements, occur as associated atoms, or molecules, which can be changed by chemical reaction into other molecules representing different atomic associations. Molecules as well as atoms possess fields of force which are the combined effect of the atomic forces of the constituent atoms.

Three States of Matter

Matter occurs in three states: (1) the gaseous state which results when the molecules or atoms have an energy of motion (kinetic energy) sufficiently great to exceed adhesional forces; (2) the liquid state in which molecules or atoms while still in vigorous and random motion are brought and held in close proximity by adhesional forces; and (3) the crystalline, or solid state, in which molecules or atoms are arranged in orderly, rigid fashion and possess only comparatively unimportant vibrational motions. Solution and evaporation are similar phenomena; in dissolving in water some substances form dissolved atomic groupings possessing an electric charge known as ions. Thus common salt forms equivalent amounts of Na^+ and Cl^- ions in solution. Crystals of these substances are considered to be associations of ions arranged in a well-defined space lattice. As a result, "molecules" as constituents of some solids are merely a form of speech; a whole crystal, perhaps several inches in size, can be considered as a single molecule. The conception that crystals result from the orderly arrangement of ions in close proximity makes it clear that, at surfaces, the valence of the constituent ions is not satisfied; to a greater degree, valence is unsatisfied at crystal edges, and to a still greater degree at corners. As a result the quantitative expression of a number of phenomena depending upon the valence-saturation of crystal ions varies greatly with the position of the crystal ions involved.

"Save the Surface and You Save All"

Of especial interest to the flotation man is the range of molecular or atomic forces—that is, the distance to which they make themselves felt. It has been experimentally determined that their effect is exhausted at a distance equal to the diameter of a few molecules; that it is small at a distance greater than a molecular diameter, though it is very great at a distance equal to a fraction of a molecular diameter. In order to visualize the minuteness of these distances as compared with objects within our range of perception, it might be of interest to remember that a gram-molecule, or 18 grams, of water contains approximately 600,000,000,000,000,000,000,000 molecules of water, so that if these molecules were cubical in shape, their edge would be 3.1×10^{-8} cm., or about one and a quarter hundred millionths of an inch! From the fact that molecular forces are very intense at extremely short range, but of no effect at a distance greater than a few molecular diameters, it follows that the reaction of minerals in flotation can be controlled by forming very tenuous films at their surface. To an extent undreamt by the varnish manufacturer, the flotation man can say: "Save the surface and you save all."

From these considerations, it follows that, if the surfaces of minerals could be coated by a variety of very thin films having radically different properties in respect to adherence to air, different floatabilities would result. Thus, under a definite set of conditions, one mineral could be made to float and another one to sink; and under a different set of conditions the reverse could be made to occur.

The selection of reagents to produce such effects depends essentially on the character of the molecular fields of force of the proposed coating, and on the solubility of the coating. It stands to reason that if a mineral could take up a coating otherwise suitable, but which is comparatively soluble, this coating would be dissolved in a very short time and its effect disappear. As a result effective coatings are comparatively little soluble; either because they are little soluble in water, or because the attraction of the superficial ions or atoms of the coated mineral is so great as to retain the molecules or ions of the otherwise soluble coating ingredient.

Solubility Relations in Flotation

Minerals are generally looked upon as insoluble substances; yet the geologist tells us that they have been deposited from solution. Even if the solubility of these substances were much greater, under the conditions of temperature and pressure associated with geological processes, the fact remains that they have, under ordinary conditions, a solubility that is not nil. The solubility of many minerals hitherto generally considered as being insoluble is fully as large as one part in one million under certain conditions. Flotation is a process so delicate that a change in concentration of certain reagents added to the pulp of a few parts in one million would be sufficient to wipe out the profits of any one of several users of the process. It is therefore essential, in flotation, to reckon with the fact that the solubility of the minerals, the solubility of the reagents, and the air or other gas used as buoying medium are all of importance.

Books on chemistry give incredibly small figures for the solubility of the base-metal sulphides. These solubilities appear to be but a mere fraction of the solubility in water of such "insoluble" substances as silica, glass, or the carbonates or hydroxides of the base metals. On the other hand, the sulphides oxidize fairly readily, so that a reaction between the oxygen from the air that is dissolved in water and sulphide grains is quite within reason, yielding as the case may be soluble salts that dissolve in the pulp or precipitated coatings at the surface of the minerals. The presence of carbon dioxide in water cannot be overlooked as a possible source of coatings at the surface of some minerals, particularly sulphides. It is well known that carbon dioxide is substantially more soluble in water than oxygen, nitrogen and the inert gases occurring in the atmosphere. As a result, the fact that the carbon-dioxide content of air is only three to four parts in ten thousand has little bearing on the carbon dioxide content of aërated water, such as is employed in flotation.

The importance and the desirability of close control of the mineral content of mill water has been so frequently stressed that it will be sufficient to point out that it is but a phase of the general fact that solubility relations of the minerals, reagents, gases, and mineral content of the circuit water are some of the most important factors in flotation.

It will seem, perhaps, that the above statement is in

contradiction with the generally accepted belief that flotation phenomena are closely associated with adsorption and surface tension. It may therefore not be out of place to dwell at some length on the relations of adsorption, surface tension, and solubility.

Surface Tension, Adsorption, and Molecular Orientation at Surfaces

The existence of fields of molecular force around molecules has already been emphasized. Within the body of a solid or liquid, the various molecular forces of attraction or repulsion balance each other; thus, a cresol molecule occurring within a body of water will be attracted equally by all the surrounding water molecules, so that it will orient itself at random. At the boundary between a solid and a liquid, or a solid and a gas, or two liquids, or a liquid and a gas, a different state of affairs exists: a water molecule at the surface of water is attracted by the molecules next to it and by those under it, but there are no forces to balance the action of the subjacent molecules, since the molecule under investigation is at the surface of the water. The various forces at play on boundary molecules result in an inward pull which is, in effect, equivalent to surface tension. In the illustration used above of water and cresol, a cresol molecule at the surface of the water is subjected to a pull toward the bulk of the water that decreases at a very steep rate with increasing distance from the surface; it follows that if the cresol molecule has various attractive properties for water in different parts of a given volume, it will become oriented at a water surface, with its most water-like side toward the water and its most water-unlike side away from it. By similar reasoning it can be shown that water molecules at the surface of water are oriented in a definite way. In general it can be said that though the structure of liquids is one of random distribution of its constituents throughout its bulk, it is orderly at boundaries with solids, gases, or other liquids.

Significance of Term "Adsorption"

The laws of thermodynamics require that the concentration of a dissolved substance be different in the bulk of the solution and in the layer of solution that forms its boundary with another liquid, a solid, or a gas. This boundary concentration is a little less than the bulk concentration, when the dissolved substance raises the boundary tension, and much greater when the dissolved substance lowers the boundary tension: under certain conditions, the boundary concentration can be several thousand times greater than the bulk concentration. The fact that the dissolved content of certain solutions can be extracted by treatment with finely divided solids without apparent chemical action has given rise to the term adsorption, to describe all similar processes of differential boundary and bulk concentrations in solutions or in gases. Examples of adsorption taken from flotation are numerous. For instance, cresol, terpineol, and amyl alcohol all adsorb both at the gas-liquid boundary and, to a lesser extent, perhaps, at the sulphide-liquid boundary; xanthates adsorb at the sulphide-liquid boundary; zinc sulphate adsorbs at a sphalerite-water boundary more readily than at a galena-water boundary. In general, adsorption may be considered as making transitions between phases in contact less abrupt by concentrating and orienting, at the boundary, those dissolved molecules or ions partaking of the characters of the two phases in contact.

The fact that dissolved substances can be removed through adsorption by the addition of adsorbents may lead to the erroneous conception that molecules that are adsorbed are permanently attached to the adsorbent. Such a picture is contrary to facts; in reality there is an exchange between dissolved and adsorbed molecules which is equal at equilibrium and produces the illusion of a static condition. As a result adsorption is essentially a reversible process.

Adsorption a Reversible Phenomenon

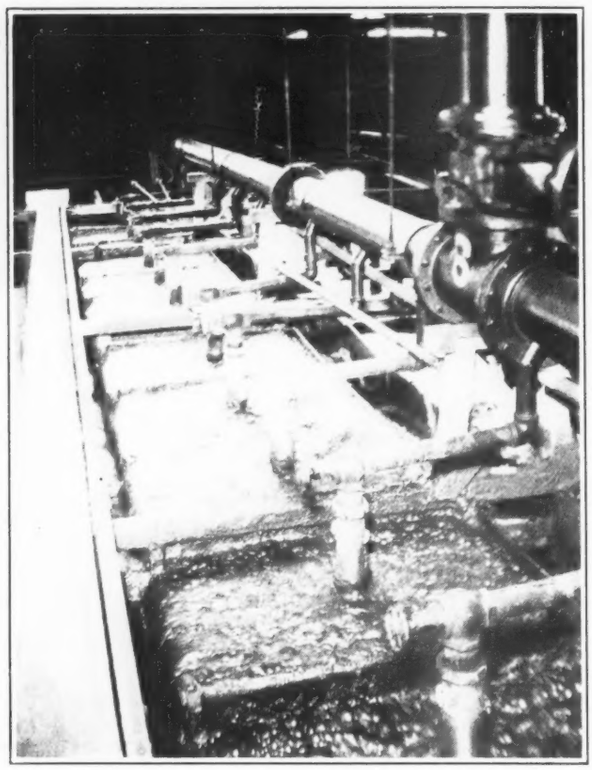
The reversibility of adsorption is the fundamental fact which makes it possible, in flotation, to sink a mineral after it has been floated, and vice versa. In general, this process, to be best accomplished, will require a certain length of time, and of stirring because of the local segregation, in the vicinity of the mineral particles, of the constituents of the adsorbed film that is being displaced; that is, the comparatively long conditioning periods required between steps in flotation are necessary for mechanical reasons as much as for chemical reasons.

It already has been indicated that adsorbed films at the boundary of a liquid phase with another phase can be leaner or richer in dissolved substance than the bulk of the solution. These films are the result of negative and positive adsorption, respectively. In flotation, positive adsorption is much more important, so that discussion will be restricted to that class of phenomena. In cases of positive adsorption, there is ample evidence to show that at saturation, the adsorbed film is entirely made up of the dissolved substance. At concentrations less than saturation the adsorbed film is incomplete, but generally more nearly complete than when the solution is saturated. To illustrate: at a concentration one-half of saturation the relative density of the adsorbed film may be 0.95, considering a complete film as of relative density 1.0. It follows that similar substances such as the various saturated alcohols exhibit adsorbed films whose density, at a given concentration, depends primarily on the solubility of these alcohols. As a rule the more insoluble a substance is, the denser are the films of positive adsorption of that substance at boundaries of the solution with other phases, provided there is no chemical action involving the dissolved substance and the substances occurring in the adjacent phases.

Adsorption—Chemical or Physical?

The restricting clause in the foregoing sentence opens up a field for discussion—namely, whether adsorption is a chemical or a physical phenomenon, and, if chemical, how it differs from chemical reaction. All the possible views on this subject are held and have been held by physicists and chemists alike. It is my opinion that all transitional stages occur between strictly chemical reaction and adsorption not involving chemical action. Thus, when an undissociated molecule which is electrically neutral leaves the bulk of a phase in which it occurs and sticks to the boundary between that and another phase, it obeys the "residual valence" forces of its constituents; and when an electrically charged atomic grouping such as an ion is adsorbed it may be following either its residual or its primary valence forces or both. By definition, chemical reaction is the result of the play of primary valence forces, so that it must be concluded that adsorption of the second kind involves chemical reaction. It may be objected, in connection with the conclusion that the adsorption of ions is a chemical reaction, that chemical reactions involve the whole mass of the reactance, whereas "chemical" adsorption involves only the surface

of one of the reactants. To this it may be replied that "chemical" adsorption does not proceed to depth because of the barrier formed by the products of reaction. Illustrative arguments, pro and con, could easily fill a bulky



Pneumatic flotation cells at the concentrator of the Cananea Consolidated Copper Company, in Sonora, Mexico

volume, so that the reader can sanely come to the conclusion that consideration of adsorption as a physical or as a chemical phenomenon is largely a matter of personal preference.

Applications of Adsorption Viewpoint to Various Simple Flotation Systems

As an illustration of the foregoing a few simple systems such as are encountered in flotation will be examined.

A—System galena-water-nitrogen, at equilibrium, consists of a saturated solution in water of lead sulphide and nitrogen, with adsorbed films of lead, sulphide, hydrogen, and hydroxyl ions and nitrogen molecules at the boundaries between galena and water, water and nitrogen, and nitrogen and galena.

B—System galena-water-air is somewhat more complicated than the preceding system because of the formation of carbonate ions by solution of carbon dioxide in water and of the oxidation of sulphide ions to sulphate ions. It may be that these ions form in immaterial amounts, and it may be that they are of importance; at any rate, the boundaries of the liquid with the solid, in particular, are likely to involve adsorbed films containing lead, sulphate, carbonate, sulphide, hydroxyl, and hydrogen ions, besides nitrogen, oxygen, and other gas molecules.

C—System galena-water-air-terpineol involves, in addition to the preceding, adsorbed films of terpineol molecules at the gas-liquid, solid-liquid, and solid-gas boundaries. One may consider that the various components of this system are competing for the surface of the galena particles as well as for that of the air bubbles. The result will depend upon the concentrations in solution of the various components and of their respective adsorptive ability.

D—System galena-water-air-terpineol-potassium ethyl xanthate involves in addition adsorbed films of xanthate ions (or of their oxidation products) and of potassium ions at the surface of the mineral and at that of the bubbles. Since xanthate does not affect the surface tension of water even at high concentrations, it is believed reasonably safe to assume that its adsorption there is unimportant. On the other hand, xanthate adsorbs very strongly at galena surfaces, either as a result of physical adsorption or of chemical reaction with the mineral surface. It is most likely that different ingredients will be in substantial control of the solid-liquid and the liquid-gas boundaries because of the dissimilarity in the properties of the solid and the gas. For instance, it is believed that when pure water and clean galena surfaces are used, xanthate dominates at the liquid-solid boundary and terpineol at the liquid-gas boundary.

E—System galena-water-air-terpineol-xanthate-potassium chromate. In addition to the list given above, chromate ions are likely to be present in substantial concentration at the solid-liquid boundary, because lead chromate is very slightly soluble, and because a chromate ion adsorbed upon a lead ion at a galena surface cannot be readily pried loose from the boundary by water molecules, which have less attraction for chromate ions than lead ions do. In this instance the surface of the galena grains will be lined largely with xanthate and chromate ions and terpineol and water molecules. The relative amounts of adsorbed xanthate and chromate ions will depend essentially upon the solubilities of lead chromate and the surface compound formed by xanthate and galena as well as upon their respective concentrations.

F—If the concentration of lead ions and of chromate ions is sufficient to exceed the solubility product of lead chromate, lead chromate will be precipitated. This precipitation will occur selectively at galena surfaces, since the concentration of lead and chromate ions is greater at that boundary than in the bulk of the solution. If the amounts of lead and chromate ions are sufficiently large, the precipitated coatings will be visible under the microscope and even tarnish galena sufficiently to be spotted by the naked eye by comparison with galena having a clean surface.

The fact that complicated chemical systems result from such simple combinations as are obtained by having one mineral in suspension with reagents of various types indicates how tremendously complicated are the systems met with in flotation practice where a half a dozen minerals or so are a common occurrence and where the number of reagents employed and soluble salts present are many more than were considered in the above illustration. It is truly remarkable that such splendid work as is done should be daily accomplished in practice.

Rather than to bore the reader by a more detailed study of systems encountered in flotation, the foregoing illustration will be left with its sketchy crudeness, and attention focussed on the character of solid surfaces in regard to their affinity for air or for water.

The fundamental fact that surfaces of liquids or solids are not alike in their behavior toward water and air is well known. Water forms round drops on paraffin, but spreads as a thin sheet over clean glass; in other words, paraffin is not wetted by water, though glass is. As a first approximation, the phenomena of flotation can be

ascribed to wetting or non-wetting of certain minerals by water. The natural question, "Why do certain minerals float under conditions under which other minerals do not float?" is simply altered to "Why are certain minerals wetted by water when others are not wetted?"; and the answer is not at hand unless the chemical character of mineral surfaces is more closely examined. Similarly, contact angles do not explain flotation; they merely are the result of the same underlying chemical behavior, as are flotation phenomena themselves; so that though a preliminary study of contact angles between mineral surfaces, water, and air may serve to predict what would happen in a flotation cell, such a study in no way explains why certain minerals float and others do not.

Returning to the conception of fields of atomic and molecular force which was stressed in the foregoing pages, attention will be called to the fact that each and every atomic grouping must have its own characteristic field of force; that is, some substances will have similar fields of force and others dissimilar ones. Primarily, however, these fields of force will be controlled by the manner in which the electrons of the atoms making up the substances whose surface is investigated are distributed. G. N. Lewis has pointed out that atoms tend either to borrow or lend electrons to neighboring atoms to an extent that will give them a most stable electronic configuration; thus chlorine atoms tend to pick up one electron each and sodium atoms tend to lose one each, with the result that by such an electron transfer, and for each chlorine and sodium atom, a sodium chloride molecule is produced. In this sodium chloride molecule, each chlorine atom has retained its extra electron and each sodium atom is minus an electron; when sodium chloride is dissolved in water it breaks up into chlorine and sodium atoms that possess a unit-negative and a unit-positive charge respectively, due to their retaining in solution that electronic configuration which is most satisfactory.

In contrast with substances in which the most stable electronic configuration of atoms is obtained through a *transfer* of electrons, might be classed those substances in which it is obtained through a *sharing* of electrons. For instance, in ethane, C_2H_6, satisfactory valence relations are satisfied only if the two carbon atoms have two electrons in common, one being derived from each carbon atom. The type of linkage typified by $H_3C—CH_3$ is therefore entirely different from that of Na—Cl in that, if ruptured, it would result in the formation of two CH_3 groups having the same electric charge instead of resulting in the formation of two groups having opposite electric charge. Substances in which the atoms are bonded through the sharing of electrons cannot break up into ions, since such a process would cause a large electrical force to be developed, without the development of an equally large charge of opposite sign. In the same way in which the difference in atomic linkage affects the properties of these substances in solution, it controls their surface fields of force.

Polar and Non-Polar Substance

Substances whose atomic linkage is of the same type as water or sodium chloride are called polar substances. They are generally substances of high dielectric constant and have uneven, or polar, fields of force surrounding their atoms or molecules. Substances whose atomic linkage is of the type opposite to that of water or sodium chloride are conversely known as non-polar substances. They generally have more even fields of force surrounding their molecules.

In this presentation, as well as in others, the polar or non-polar character of substances has been stressed. It is perhaps desirable to indicate that this classification is not meant to exclude the possibility of some substances possessing intermediate polarity. In fact, the high non-polar characteristic of elemental sulphur may be partly responsible for the less polar characteristics of base-metal sulphides as compared with other minerals. Those substances whose molecule is large enough to justify separate consideration of the polarity of different parts of the molecule may be called polar-non-polar—that is, they are polar in one part and non-polar in another. These substances are of especial interest in connection with flotation, inasmuch as all frothing and collecting agents belong to this class.

No Affinity Between Polar and Non-Polar Molecules

Viewed as an effect of relative polarities, the non-spreading on water of non-polar liquids, such as nujol, might be considered to be a result of the fact that no portion of a non-polar molecule has any marked affinity for the eminently polar water molecules. The same viewpoint interprets satisfactorily the spreading on water of polar-non-polar substances, such as oleic acid, the molecules of which have a polar or waterlike portion that becomes dissolved in water and a non-polar or water-unlike portion that refuses to dissolve. Depending upon the relative magnitude of the polar and non-polar portions, more or less of these molecules will dissolve—that is, the solubility of these substances increases with the number and size of waterlike groups of atoms, but decreases with that of the water-unlike groups of atoms.

In the same way in which polar-non-polar substances spread on water with the polar end of their molecules oriented toward the water, similar substances spread at the surface of polar solids. In this case, however, owing to the rigidity of the solid phase, it is more difficult to observe the phenomenon. This spreading is, of course, one form of adsorption, so that the same end can be attained by allowing a vapor or a solution of the polar-non-polar substance to play on the surface of the mineral.

For the reason that flotation results from the adherence of mineral particles to air bubbles, the various reagents can be classified into those which affect the surface of the bubbles and those which affect the surface of the minerals; in a different manner flotation reagents can be classified according to the character of the reagent molecules into polar-non-polar reagents and polar reagents. A third classification involving the function of the reagents has been recently proposed and is as follows:

1—Frothing agents provide the froth.

2—Collecting agents cause certain mineral particles to adhere to the air bubbles.

3—Depressing agents prevent certain otherwise collectable mineral particles from adhering to air bubbles.

4—Activating (modifying) agents facilitate or activate the collection of certain mineral particles.

5—Toxic agents kill the froth and decrease collection.

6—Antitoxic agents remove toxic agents.

Collecting agents or collectors are of fundamental importance; it seems fitting, therefore, that they should be considered at some length. To be able to understand fully how they work, it must be remembered that the range of molecular forces is limited, for practical purposes, to a distance not exceeding a molecular diameter. This is shown beyond doubt and with great accuracy in the spreading of fatty acids on water. Experimental

work conducted at the laboratories of the Department of Mining and Metallurgical Research of the University of Utah has shown that collectors, in amount insufficient to form complete monomolecular films at the surface of various sulphides, result in complete recovery of these sulphides in place of little or no recovery. The lack of necessity for thicker films furnishes circumstantial proof that a monomolecular coating is sufficient to alter substantially the properties of the subjacent solid. The mechanism of the coating of mineral particles by slightly soluble collectors, such as the soaps or thiocarbanilid, seems to be composed of a solution step and an adsorption or precipitation step which occur practically simultaneously and affect each other to a large extent until equilibrium is reached. It is quite conceivable that such a coating process might continue, if sufficient collector is present, until the coatings at the surface of the mineral particles are thickened as the result of crystal growth. In selective flotation, however, where small excesses of reagents are frequently fatal, the amounts of collecting agents are rarely sufficient to form complete monomolecular films at the surfaces of the minerals on which they adsorb, even if completely adsorbed.

All collecting agents are substances of the polar-non-polar type—that is, substances whose molecules become oriented at boundaries. Such molecules on adsorbing at mineral-water boundaries become oriented with their polar end either toward the water or the mineral. Orientation with the non-polar end toward the mineral is unlikely, since no attraction can exist between polar mineral surfaces and the non-polar portions of the reagent molecules or ions. If there is adsorption it must then be such that the polar ends of the adsorbed molecules are oriented toward the solid. It may, therefore, be concluded as substantially true, that in order that mineral particles adhere to air rather than be wetted by water, it is sufficient that they be coated with a more or less complete monomolecular film of polar-non-polar molecules or ions oriented with their polar portion toward the mineral.

Particles coated by a collecting agent present a non-polar, water-like surface to water. This is, of course, a most unstable condition, with the result that further adsorption will modify it if possible. Since molecules of oxygen, nitrogen, and other gases composing the air exist in solution in water, it is probably that they adsorb most readily on a surface which is unstably adjacent to water, such as a collector-coated mineral particle. This adsorption may be the basis for gas precipitation and bubble growth as is obtained in pulps where differences in pressure at different points result in under- and supersaturation of the pulp solution with respect to the atmospheric gases. It is also likely to favor adherence of mineral grains to pre-existing bubbles.

Function of the Frothing Agent

In order that mineral particles bonded to air bubbles by means of a collecting agent be recovered as a froth, it is necessary that the bubbles be sufficiently resilient so as not to rupture as soon as they reach the surface of the water and thereupon drop their load of mineral particles. To obtain efficient floating it is further desirable to have present as many bubbles as possible. These ends are obtained through the use of frothing agents which adsorb, generally positively, at gas-liquid boundaries.

The difference in concentration of frothing agent in the bulk of a flotation pulp and at water-air boundaries causes the surface tension of the pulp solution to be less than it would be if there were no such concentration difference. As a result, when a bubble-wall is stretched through agitation or encounter with another bubble or a cell-wall, the increase in surface results in momentary decrease in concentration of frothing agent at the surface, and a corresponding increase in surface tension. This surface tension increase counteracts the stretching agency and prevents bubble collapse.

In practice, frothing agents are always of the polar-non-polar type, although it is conceivable that substances of the polar type which raise the surface tension of water might be used in greater concentration in place of the presently used polar-non-polar reagents. Present-day frothing agents are frequently mild collectors, particularly for the most floatable sulphides, if the ore pulp contains no other constituents that adsorb at the surfaces of these sulphides.

Where it is desired to make a bulk float of all the sulphides occurring in an ore, a frothing agent and a collecting agent are necessary and sufficient (in some instances one reagent will do both frothing and collecting duties). On the other hand, where it is desired to float one sulphide from another, the use of added reagents is necessary, these reagents having for purpose the "deadening" or "sickening" of one or several sulphides by lining their surface with polar, non-floatable, coatings.

Modifying Agents

In view of the generality of adsorption phenomena, it should be expected that the addition of non-collecting non-frothing salts to the flotation circuit should result in an uneven distribution of the ions derived from these salts in the bulk of the solution and at the solid-liquid boundary. Where such added salts produce ions that do not form comparatively insoluble salts with one or the other of the atoms composing the mineral surface, there is no way of predicting whether the boundary concentration will be greater or smaller than the bulk concentration. On the other hand, where one or both of the ions of the added salt form comparatively insoluble compounds with the mineral surface, they will be adsorbed positively by it. A well-known particular case is the adsorption from solution of an ion occurring in the solid phase such as the adsorption of silver or iodine ions by silver iodine. Ionic adsorption is not restricted to the picking up from solutions of one of the ions occurring at the mineral surface, but may involve any ion present in solution that forms an "insoluble" compound with one of the atoms of the mineral surface. This explains the deadening or "sickening" of pyrite and sphalerite by cyanides, of calcite by sulphates and oxalates, of galena by chromates and phosphates, of quartz by silicates.

More often than not the situation at mineral surfaces is considerably more complicated than has just been outlined, in that more than one ion is adsorbed positively. If, for instance, zinc sulphate and sodium cyanide are present together in a pulp, zinc cyanide will precipitate, provided its solubility is exceeded. If sphalerite particles are present the concentration of the zinc ion and of the cyanide ion at the sphalerite-water boundary will be greater than in the bulk of the solution, so that precipitation will occur there more readily. It may even occur there at bulk concentrations that do not lead to precipitation. As a result, sphalerite acts as a scavenger for the zinc cyanide present, and its surface becomes more or less completely coated by it.

It will be apparent from these considerations that, other things being equal, a depressing agent involving one of the ions of the mineral surface as well as some other ion,

as constituents of the flotation pulp, will be more effective than a depressing agent involving only one added ion. In practice the conscious addition of but one depressing ion is frequent, and yet two or more ions may be contributing to the formation of the desired depressing coating. Thus, fairly high alkalinities result in depression of pyrite and of sphalerite, partly because of the presence of soluble iron and zinc salts in the ore. In determining which added ingredient results in depression, it is well to keep in mind the fact that some other less obvious ingredient may be equally responsible for the formation of a depressing coating.

The depressing agents that so far have been discussed involve distinctly non-colloidal ionized salts. Another class of depressing agents is furnished by protective colloids—gelatin, for instance. These substances owe their name of protective colloids to the fact that they allow certain metallic substances, such as gold, to remain dispersed in water by coating the surface of the dispersed particles. These protective colloids are made of clumsy molecules that are largely polar, and yet are truly soluble because of their bulk. These molecules are known to form hydrates, or to adsorb water most readily, so that when they coat particles they really constitute a "hyphen" between them and water. Particles coated by these waterlike protective colloids are readily wetted and therefore sunk. Little is known concerning their flotation properties and selectivity.

Copper Sulphate and Other Activators

In some instances coating the surface of minerals by polar substances results in making them substantially more floatable—that is, these coatings provide a better base for the adherence of collecting agents. Reagents that play such a part are known as activating or modifying reagents. It is well known, for instance, that copper sulphate rejuvenates sphalerite "sickened" by zinc cyanide. This is partly because the cyanide is used up by copper to form slightly ionized complex copper-cyanide ions, and partly because the sphalerite surface has been replaced by the more floatable copper-sulphide surface. In the same way calcite can be lined with lead carbonate or copper carbonate by introducing in solution copper or lead ions. The change in the character of the calcite surface can then be made clear by allowing the well-washed mineral to be acted upon by sodium sulphide, yielding a visible coating of copper or lead sulphide on the calcite.

The foregoing general types of reagents are best known, but do not cover the entire range of possible reagents that play a part in flotation. For instance, soluble salts derived from the ore by solution of its soluble parts or by oxidation of otherwise insoluble minerals may be considered as unwanted reagents requiring control. Their effect may be (1) to activate the surface as outlined above; (2) to act as a depressant in conjunction with some added depressing agent, in which case they are sometimes useful and sometimes undesirable; or (3) to destroy flotation. Where such powerful destruction of floatative properties occurs, these metallic salts may be called toxic reagents. Their mode of operation is not well understood. The effect of these metallic salts may sometimes be overcome by adding to the pulp definite amounts of soluble carbonates or hydroxides which serve to precipitate them. The alkaline salts or alkalis frequently used in practice to control differential flotation thus appear to be essentially antitoxic reagents, although they are also contributing to the formation of certain selective depressing coatings or, sometimes, constitute the sole depressing agent.

In this article the attempt has been made to summarize the chemical aspects of how flotation works, and liberal use has been made of the imagination of the writer, in picturing atoms, electrons, and the like at work. Our knowledge of surface reactions, even outside of flotation, is only a beginning; and progress is so rapid that what appears to be true one day is disproved the next, and vice versa. The developments of flotation research in the next few years will, no doubt, disprove certain ideas presented in this paper; others will be vindicated. The indulgence of the reader is therefore asked.

Seven Tentative Conclusions

In spite of our lack of perception of a number of the effects of forces discussed in this article, the following conclusions appear justified:

1. The ease of wetting of substances and tendency to adhere to gas depends upon their surface only. Surfaces are polar (wetted) or non-polar (not wetted).
2. By proper treatment of these surfaces the floatability of mineral grains can be varied.
3. These effects are obtained by the judicious use of collecting (non-polarly coatings), depressing (polarly coating), and activating (polarly coating) agents.
4. Flotation is operative only if a frothing agent is in the pulp.
5. The effects of reagents on surfaces depend upon their concentration, adsorption, and solubility.
6. Chemical reactions within the pulp, at the boundary between the solution and mineral particles, between mineral particles and solutes, or between various mineral particles accompany and follow adsorption.
7. Nearly all of the effects observed, if not all, have at some stage or other been brought about by solution of the reactant or reactants. Therefore, all of the ingredients entering into a flotation system must have their solubility considered as of sufficient magnitude to cause an effect until the contrary has been definitely proved.

In conclusion I wish to mention that the views expressed in this paper are in part the result of experimentation which I and my associates have personally conducted in the Department of Mining and Metallurgical Research of the University of Utah, and in part borrowed from the published data of well-known students of flotation, to whom thanks are due.

Nickel and Copper Refining in Wales

The Swansea nickel industry is carried on by the Anglo-French Nickel Company, Ltd., and the Mond Nickel Company, Ltd., the latter doing practically the whole of the import and export business, says *Foreign Trade Notes,* of the U. S. Department of Commerce. This firm imports copper-nickel matte from its Canadian mines and exports nickel in cubes and rondels, and nickel and copper sulphate, to all parts of the world, although some of its production is consumed in Great Britain.

The copper industry of Swansea has been on the decline for twenty-five years. Large quantities of copper ore were formerly treated at the local plants, but this trade has fallen off on account of the impracticability of handling ore so far from the mines. The local works have, therefore, devoted their plants to the refining of copper and to the manufacture of metal articles.

Experimental Reduction With Hydrogen of

Bolivian Tin Concentrate

Third of a Series of Six Articles Based on Physico-chemical Studies in the Metallurgy of Tin

By C. G. FINK and C. L. MANTELL

Respectively, head, Division of Chemistry, Columbia University; and consulting chemical engineer, Pratt Institute, Brooklyn

IN A PREVIOUS PAPER the gaseous reduction of stannic oxide and ferric oxide by hydrogen was reported and discussed. This paper carries the same work forward in respect to tin concentrates. In practically all the previous work on gaseous reduction of tin ores it has been observed that metallic iron did not appear as such after reduction and cooling of the charge. The oxides of iron were always evident. From the fact that metallic tin was always found, and no metallic iron, it was concluded by earlier investigators that the oxide of tin was more readily reduced to metal than were the oxides of iron. Our previous work shows this reasoning to be unsound.

OXIDATION OF HYDROGEN-REDUCED METALLIC IRON AND METALLIC TIN

An investigation was made to ascertain why the oxides of iron always occurred and metallic iron was not found. We have found no difficulty in producing hydrogen-reduced iron either from any of the iron oxides, or from those oxides mixed with the oxides of tin, provided the charges are cooled to room temperature after reduction in a reducing atmosphere. A quantity of hydrogen-reduced iron was made and its oxidation studied. Some samples of commercial hydrogen-reduced iron as well as finely ground electrolytic iron were procured. The oxidation points of these materials were studied.

Gram samples of these materials were placed in alundum boats in a glass combustion tube, heated by an electric furnace the temperature of which could be regulated. Temperatures were taken by a calibrated mercury-in-glass thermometer, the bulb of which was opposite the center of the boat. All three of the varieties of iron mentioned showed rapid oxidation by moist air at 200 deg. C. The air was drawn through absorbent cotton, freed of carbon dioxide by passage through soda-lime, and saturated with moisture by passage through a bubble-bottle filled with water and maintained at room temperature.

The hydrogen-reduced iron oxidized more rapidly than did the electrolytic iron after contact with the stream of air for 30 min. The hydrogen-reduced iron was pyrophoric at this temperature. All three forms of iron showed definite oxidation at 150 deg. C. and at 100 deg. C. At 75 deg. C. the electrolytic iron showed relatively little oxidation, but the hydrogen-reduced product showed an appreciable amount. At 50 deg. C. only the hydrogen-reduced iron made in the laboratory showed oxidation, and the commercial material did not.

The same experiments were repeated using dry air. Results were quite similar and in the same sequence, with the exception that the finely divided hydrogen-reduced iron was pyrophoric as low as 150 deg. C.

Apparatus was arranged so as to allow reduction of ferric oxide to iron by hydrogen, then allowing the introduction of nitrogen to sweep out the hydrogen, and then allowing a stream of air to be introduced. Boat loads of freshly reduced iron were found to be pyrophoric and completely oxidized at 200, 150, 100, 75, and 50 deg. C., and in one case even at 40 deg. C.

Hydrogen-reduced iron, prepared at temperatures far below its melting point, is in the form of a very fine powder. The average particle size will be of the order of 2 to 3 μ. The surface of these particles in comparison with their volume is enormous. Their ready oxidation at low temperatures is thus easily understood from what we know of surface absorption phenomena.

Metallic tin, when the reduction temperature is 200 deg. or more above its melting point, tends to form small drops or globules, thus reducing the exposed surface. Experiments were made with tin particles reduced at low temperatures to determine their temperature of oxidation. The experimental procedure was the same as outlined above. The tin particles were of the order of 2 to 3 μ. There was little oxidation of tin at 50, 75, 100, and 150 deg. C. either by moist or by dry air over a half-hour period. At 200 deg. C. there was a slight oxidation, which grew less after passing beyond 230 to 250 deg. C. when there was a tendency toward the formation of globules. At no temperature below 250 deg. C. nor at 250 deg. C. was the tin pyrophoric.

We thus have the explanation for the absence of iron in the experiments of other workers in the reduced masses resulting from the reduction of mixed iron-tin oxides or of iron-bearing tin concentrates. Knowing that tin was not oxidized to any appreciable extent below its melting point, the furnaces used were usually discharged after cooling down to or a little below the melting point of tin. The reduced iron, being freshly prepared and very active, is readily re-oxidized at these temperatures—so readily oxidized that it is pyrophoric. On contact of the reduced masses with the air, the reduced tin metal is not affected, but the reduced iron changes over entirely to its oxides.

Hydrogen reduction of Bolivian tin concentrates using charges of 1 kg. shows time-temperature reduction curves of the same form as the tin-oxide-hydrogen curves. The hydrogen gas was not purified except for the removal of moisture. The furnace tubes were of wrought-iron pipe 1 in. in diameter and 48 in. long, of which 30 in. was heated electrically. At any temperature the time for complete reduction was a function of the hydrogen flow velocity as shown in Fig. 1. Time of reduction varied with the mesh of the ore up to 30 mesh, as shown in Fig. 2. Beyond this screen size further grinding of the ore did not seem to increase the speed of contact between ore particle and gas molecule.

Effect of Gangue on Reduction Efficiency

The process of gaseous reduction depends for its success upon the absence of all slagging phenomena until complete reduction is effected. Even incipient fusion prevents the intimate or rapid contact of ore and gas, slowing down the reduction finally to complete stoppage when the ore particles become slagged or glazed over. In the particular Bolivian concentrates[1] used in our work, no difficulty was encountered due to the low fusing point of tourmalines, gangue materials, or slagging ore constituents at the temperatures employed. After reduction the furnace charge was cooled in an atmosphere of hydrogen to below the melting point of tin. Iron was always found as oxides in the reduced charge, the cause of which has been explained above.

Vapor Pressure of Tin

No direct experiments on the vapor pressure of tin over any range of temperatures were made. There is much indirect evidence that it would not be measurable below 1,130 deg. C. Northrup (*Chemical and Metallurgical Engineering*, Vol. 17, 1917, p. 689) uses tin in graphite as a thermometer to 1,680 deg. C. or above without difficulty.

Williams, Sims, and Newhall (Preprint, Vol. 43, 1923, paper No. 23, American Electrochemical Society) found that with an oxidizing blast some tin could be driven off from tin-plate scrap in the cupola, but practically none in the reducing atmosphere of an electric furnace, and concluded that the loss is mechanical, due to burning to oxide, the oxide particles being light enough to be carried off.

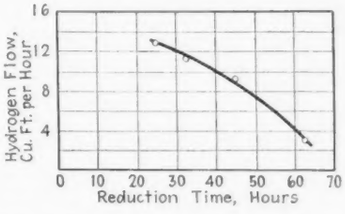
Watts (*Trans.* American Electrochemical Society, Vol. 12, 1907, p. 141) cites Moissan's experiments to show that some tin can be volatilized at arc temperatures, but Moissan volatilized platinum, molybdenum, and tungsten also. Tin was found less volatile than copper. Mott (*Trans.* American Electrochemical Society, Vol. 34, 1918, p. 294) gives a rough vapor-pressure curve from which the approximate vapor pressure of tin might be taken, and includes a copious bibliography. Ruff and Bergdall (*Zeit. anorg. Chem.*, Vol. 106, 1919, p. 76) give data on boiling points, as does Greenwood (*Trans.* Faraday Society, Vol. 7, Pt. 2, 1911, p. 151). The boiling point of tin is given as being anywhere from 2,260 to 2,440 deg. C. In extremely high vacuum, Tirde and Birnbrauer (*Zeit. anorg. Chem.*, Vol. 87, 1914, p. 129) found volatilization of tin at 880 deg. C.

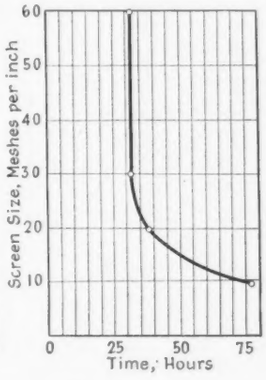
All the data indicate that the calculations of Johnston (*Jour. Ind. Eng. Chem.*, Vol. 9, 1917, p. 873) are pretty close to correct, though these are made on a theoretical basis and not checked by direct experiments. His figures are as follows:

Temperature, Deg. C.	Pressure of Tin, Mercury, mm.
1010	0.001
1130	0.01
1270	0.1
1440	1.0
1660	10.0
1850	50.0
1940	100.0
2260	760.0

In its final solution, the method of tin recovery from the reduced charge was simple. The concentrates had the following analysis: SnO_2, 86.2 per cent; Sn, 67.95 per cent; Fe, 4.19 per cent; Fe_2O_3, 5.65 per cent; Sb, 0.04 per cent; As, 0.010 per cent; Cu, 0.036 per cent;

Fig. 1—Curve showing flow of hydrogen and time of reduction at constant temperature. Fig. 2—Curve showing screen size and time of reduction





Bi, 0.296 per cent; WO_3, 1.42 per cent; SiO_2, 1.73 per cent; and S, 0.28 per cent. If the ore charges were stirred or rabbled continuously during reduction, thus exposing fresh surfaces and allowing the molten tin particles to flow together, about 80 per cent of the tin content of the ore was directly fluxed from a non-fluid slag.

This metal was about 70 per cent of the weight of the concentrates charged into the furnace. The remaining 20 per cent of the tin content of the concentrates could be almost completely recovered by fusing the residues at 1,000 to 1,050 deg. C. when the gangue formed a very liquid slag and the metallic tin readily settled out. The slag contained only small amounts of tin amounting to 1 to 2 per cent of the total tin content of the original concentrates.

The final slags were from 10 to 12 per cent of the original weight of the ore. The tin contained all the reducible metals, bismuth, antimony, lead, copper, and silver, but only a small amount of the iron. Arsenic was absent in the tin produced, and had evidently been volatilized in the process. Tungsten and molybdenum were reduced to their lower oxides only, and did not find their way into the metal.

A low-temperature arrangement of apparatus for the reduction of tin concentrates by hydrogen was made. The work was purely qualitative. The apparatus train was as simple as possible. A high-pressure hydrogen cylinder with reducing valves was used as a source of gas. The tank outlet was connected by heavy rubber tubing to the reduction-furnace tube. The furnace tube was of hard glass, heavily walled and about 0.75 in. in diameter, and 30 in. long. In this work the finely ground (35-mesh) concentrate was held in clay combustion boats in the center of the furnace tube. Temperatures were measured by a 400 deg. C. nitrogen-filled mercury-in-glass thermometer. The entire thermometer was inclosed in the glass furnace tube.

The exit end of the furnace tube was connected by rubber tubing to a bubble bottle filled with water. Concentrates were the same as those used in previous work. They were ground in a ball mill for 24 hours and

[1]Furnished by the Williams-Harvey Corporation.

screened so that everything passed through the 35-mesh standard Tyler screen. No purification of hydrogen was made. Charges of approximately 10 gm. of concentrate were used per run. Flow of hydrogen was at the rate of 4 to 7 liters per hour. The original concentrates were brownish red in color owing to the presence of iron compounds. It was particularly desired to determine whether the reddish brown color of the ore was changed early in the reduction.

Run 1—Average temperature, 345 deg. C.; temperature range, 325 to 363 deg. C.; time, 72 hours. Ore showed decided change in color after 9 hours. The charges were cooled in hydrogen. All of the metallic oxides in the concentrate were reducible with hydrogen. Tungsten and molybdenum are reduced to lower oxides. These are fairly insoluble in hydrochloric acid, and were found in the gangue. All of the reduced metals were soluble in hydrochloric acid. The cooled charge was almost entirely soluble in dilute acid, except for the gangue, which was largely siliceous.

The residue from the acid treatment was carefully examined under the microscope. It was very clean, showing chiefly white and rose quartz, garnet and tourmaline. It was particularly observed that the color of rose quartz (which coloring is due to metallic oxides) was not changed as a result of the action of hydrogen. Evidently the coloring iron oxide is very tightly inclosed in some specimens.

The gangue was washed free of chlorides, dried and subjected to hydrogen reduction at 750 deg. C. for two hours. The material was cooled in hydrogen and leached with hydrochloric acid, and the solution was tested qualitatively for tin. Mercury bichloride showed only a very faint test for tin. It is to be concluded, therefore, that practically all of the tin was recovered from the concentrates by reduction and leaching.

Run 2—Average temperature, 425 deg. C.; time, 46 hours. Ore color change seen after 9 hours. Hydrochloric acid treatment of the reduced charges gave clean gangue residues. Microscopic examination of the gangue was made as before with the same results. The gangue was washed, dried, and treated with hydrogen at 750 deg. C. as in the previous run. Qualitative tests for tin gave only traces of its presence.

Run 3—Temperature, 460 deg. C.; time, 46 hours. Ore color change was observed after 8 hours. Very clean gangue resulted after treatment of the charge with one liter of 18 per cent hydrochloric acid. Microscopic examination of the reduced charge before leaching disclosed a very large number of very small tin pellets. Secondary reduction of the washed gangue at 750 deg. C. resulted in negative tests for tin by mercuric chloride, but traces appeared with the ammonium molybdate test.

Run 4—Temperature, 540 deg. C.; time, 24 hours. The entire surface of the reduced charge was covered with tin pellets. Leaching with hydrochloric acid as above showed practically complete solubility of the metal content of the ore. The gangue was very clean. Secondary reduction of the gangue gave results identical with those of Run 3.

Each one of the leachings was electrolyzed with carbon anodes and brass cathodes at a current density of 5 amp. per square foot. The deposited metal was in the form of long needle crystal masses. This type of deposit is characteristic of the acid tin bath.[2] The deposits were not very adherent.

Run 5—This was made by placing the charge of ore directly in the glass tube, eliminating the combustion boat. Time of run was 72 hours, the average temperature 320 deg. C. The reduced charges had the same appearance and properties as those of the previous runs. The concentrate or the reduced constituents had little effect on the glass other than that of mechanical abrasion. In this run, at least, glass was a sufficiently good refractory for tin metallurgy.

We observed throughout these runs that there is a definite color change of the tin concentrate during reduction. This color change is due to the greater speed of reduction of ferric oxide over that of stannic oxide. At low temperatures it is possible to have "metallurgy in vitro" in the difficult case of metallic tin. Metallic tin in the liquid phase at 1,400 deg. C. has been shown in industry to be most damaging to almost all of our best refractories. We have shown that it is possible to have low-temperature metallurgy with satisfactory and almost complete metal production from Bolivian tin concentrates. This investigation shows possibilities in a field as yet but little explored. It would be most interesting to have the reactions of the old-time metallurgists to the idea of using glass as a refractory for metals; or their reactions to tin metallurgy with the disastrous refractory problem removed.

This investigation shows also that there may be possibilities of winning tin from its ores by low-temperature reduction, leaching of the reduced charges (cassiterite has so far withstood all attempts to leach it), with electrolytic precipitation of the metal in the leaching liquors. The leaching solutions after partial removal of their metal content can be used again for leaching of fresh reduced ore.

Using hydrogen for the reduction of tin concentrate, a rough estimate of the power consumption is based on the following factors: One pound of metallic tin requires for its reduction from cassiterite (SnO_2), 6 cu.ft. of hydrogen gas. One kilowatt-hour produces 7 cu.ft. of hydrogen gas by the electrolysis of water.[3] The theoretical value is about 9 cu.ft. Power requirements for the production of hydrogen therefore are 0.86 kw.-hr. per pound of metallic tin; or 1,030 kw.-hr. per ton of 60 per cent tin concentrate. The reaction is effected economically at 750 deg. C. At this temperature the power requirements for heating represent an additional 1.75 kw.-hr. per pound of tin, or 900 kw.-hr. per ton of 60 per cent concentrate. The total power requirements then appear as 1.6 kw.-hr. per pound of tin, or 1,930 kw.-hr. per ton of 60 per cent concentrate.

Smelting costs employing carbonaceous fuel for reduction are about $48 per ton of 65 per cent concentrate.[4] About 41 per cent of this cost is for fuel,[5] or $19.68 per ton of 65 per cent concentrate. The same operation by gaseous reduction, with power at $0.003 per kilowatt-hour, will amount to $5.97 per ton of concentrate. Even if power were as expensive as $0.01 per kilowatt-hour the total cost of energy for reduction by hydrogen would be $19.30 per ton of concentrate. Gaseous reduction would not have to carry the 1 per cent of the smelting cost for fluxes that carbon reduction entails, and the 15 per cent for general expense (a portion of which is for refractories) would most likely be materially reduced.

[2]Mantell: "Electrolytic Tin." *Trans.* American Electrochemical Society. Vol. 45, p. 431 (1924).

[3]Allan: *Trans.* American Electrochemical Society. Vol. 41, p. 239 (1922).

[4]Jones: "Tin Fields of the World." Mining Pub. Ltd., London (1925).

[5]Sixteenth Ann. Report, U. S. Geological Survey (1896). The ratio still holds good in modern practice.

Automatic Equipment for Reclosing and Sectionalizing

PART II—CONCLUSION

By A. E. ANDERSON
Switchboard Department, General Electric Company

ALTHOUGH the type of feeder mentioned in Part I* covers most applications, it is necessary at times to make certain slight modifications either in the feeder or in the associated equipment to obtain the most desirable operating results. A few of the more common cases are given in the following paragraphs:

With a stub-multiple reclosing feeder, reverse-power protection for a manually operated machine is obtained by a direct-current reverse-power relay. The contacts of this relay are normally closed and are connected in series with an overspeed limit device on the machine. When reverse power occurs in an amount slightly less than that required to run the machine light, the reverse power relay opens its contacts. This operation de-energizes the undervoltage release on the machine breaker. The operator must reclose this breaker before service can be restored.

In the foregoing case it is necessary for the operator to reclose the machine breaker. This operation may be performed automatically by using a line contactor in place of the circuit breaker and adding a voltage-directional relay. The direct-current reverse-power relay will open the line contactor when reverse power occurs. However, this contactor will not reclose (automatically) until the generator voltage is slightly higher than that of the bus.

*Part I appeared in issue of Dec. 10, 1927.

With two manually operated machines of equal rating and one reclosing feeder it is desirable to have the reclosing feeder trip on a certain value of overcurrent if both machines are connected; but if only one machine is connected, the feeder should be tripped at half this value.

Ordinarily each machine is connected to the direct-current bus through a circuit breaker and reverse-power relays. In addition, each machine is provided with an overcurrent relay. The contacts of these relays are in series and so control the coil circuit of the feeder contactor that, if either machine becomes overloaded, the reclosing feeder is disconnected.

Each of the two manually operated circuit breakers has an auxiliary switch arranged to control an auxiliary contactor. Each of these contactors controls two equal sets of load-indicating resistors which are placed in the feeder circuit in the customary manner. When both air circuit breakers are closed, the two sets of load-indicating resistors are in parallel and the reclosing value will be double the amount obtained when only one machine is connected to the bus.

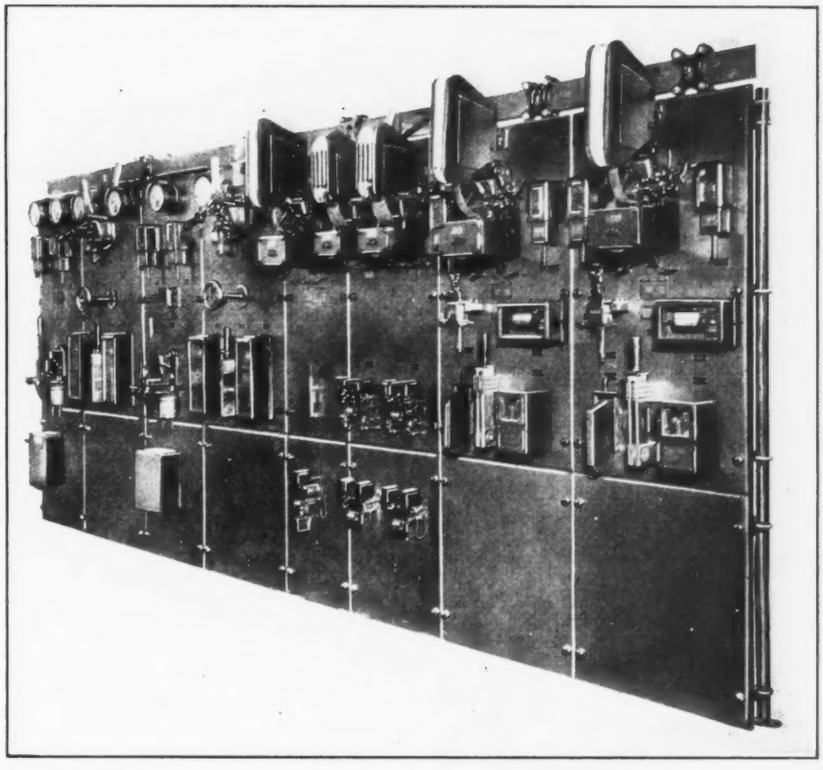


Fig. 5—Devices for partial automatic control of two 600-volt d.c. 300 kw. synchronous converters, with load-limiting resistors in machine circuit. Load supplied through two 1,500-amp. stub-multiple reclosing feeders. Furnished to M. A. Hanna Co., Duluth, Minn., for open-pit iron-ore service

With one or more manually operated machines and two or more reclosing feeders where the total overcurrent calibration of the feeders is greater than the total machine overload capacity, each machine is provided with a

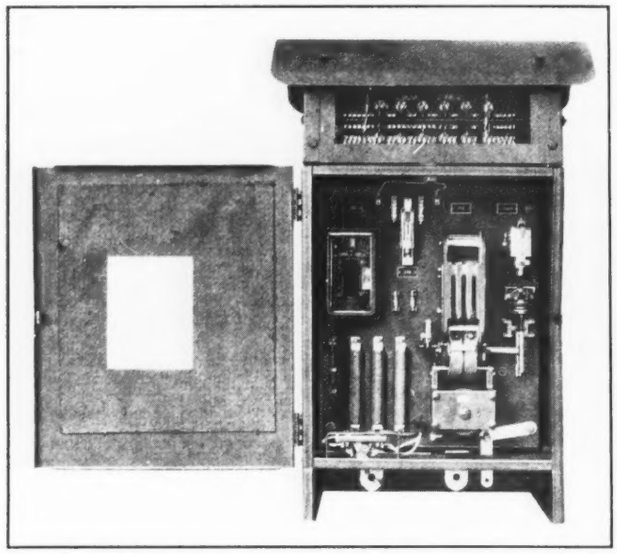


Fig. 6—Inside of mine sectionalizing and reclosing unit. Stub-multiple feed in either direction, 900 amp., 275 volts, d.c.

direct-current overcurrent relay. Whenever the load becomes too great, one of the overcurrent relays opens one (or more) particular automatic reclosing feeder. Enough feeders are tripped in this manner to prevent the total overcurrent calibration of the feeders remaining closed from exceeding the total connected machine overload capacity. The overcurrent relay on the machine circuit resets at from 60 to 70 per cent of its pick-up value and thus permits the opened feeders to reclose in the usual manner.

Applied at an Iron Mine

Fig. 5 illustrates such an application. In this case two 600-volt, 300-kw. synchronous converters are used. The reclosing feeders are of the stub-multiple type. This particular installation was made in connection with an open-pit iron-ore mine and was equipped with load-limiting resistors in the machine circuit. By the use of load-limiting resistors it was possible to use converters of 300 kw. capacity, and to operate both machines for the full load required by three locomotives. If it becomes necessary to shut down one machine for repairs, it is possible to operate the haulage system at 75 per cent capacity and to limit the peak load on the machine to a safe value. In addition, it is more economical to handle the locomotive load when switching on Sundays and idle days with only one converter. The reclosing value of each feeder is varied, depending on whether one or two machines are in operation.

Inasmuch as the shovel power supply to this mine is 2,200 volts (60 cycle), the load on the automatic substation is entirely tractive in its characteristics. Where the load is essentially tractive, load-limiting resistors can give the desired result.

The location of load centers in mining application cannot always be accurately predetermined with the view of laying out an economical feeder system. The principal difficulty encountered is that, as the mine grows, the feeder system may spread out in various directions. Usually, the feeder system, as originally installed, is comparatively simple. As the mine grows it is found that certain stub-end circuits can be conveniently tied together, which results in a better use of the feeder copper. This process eventually results in a distribution network, which, in addition to having the advantage of utilizing the copper efficiently, has the disadvantage that a fault in any part of the system will affect the entire network. Such action is likely to cause serious delays. One common remedy for this is to install manually operated lever switches at convenient points. Though the switches can isolate the fault, it is found that it requires too long a time for the mine electrician to find the proper switch and then get in touch with the substation operator so that power may be re-established. The larger the mine, the greater the number of sectionalizing points should be. This naturally results in a longer time to find the proper manually operated switch, with a consequent slowing-up of production because of power interruption. The use of manually operated air circuit breakers at these points may give the desired tripping action, but there the problem is one of determining which breaker should not be closed, and closing any others in series with it which may have tripped on the same overcurrent condition. To meet this situation some mines have been divided into several power zones. Each zone is supplied by a feeder direct from the substation. Such a procedure requires increased cross-section of the feeder copper in order to maintain the desired operating voltage. Though this method localizes the fault in one section, and prevents a general tie-up of the mine, it does not tend to reduce the fire hazard at the working face,

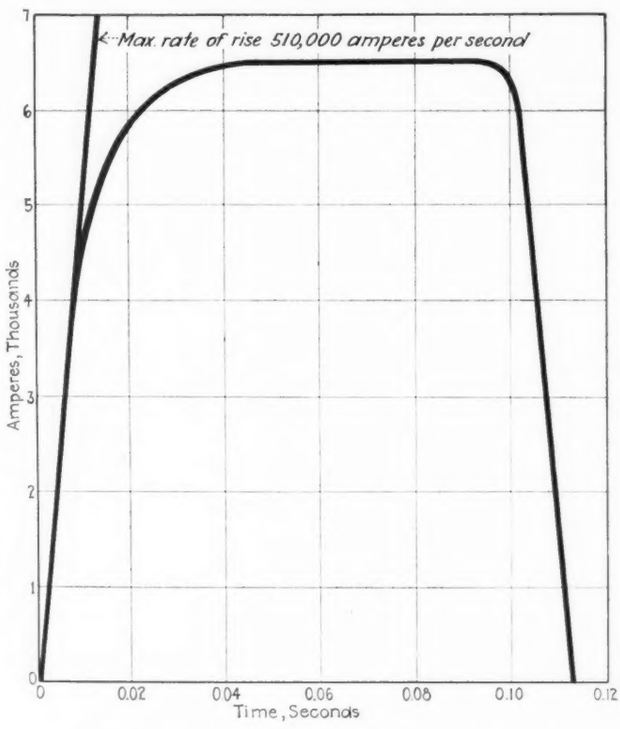


Fig. 7—Time-current values obtained during circuit interrupting test

since it is necessary to trip the substation breaker which is set to carry total peak loads on the feeder. Fault currents may be obtained, on some of the smaller capacity circuits, which will not trip the substation breaker

and yet be of a disastrous nature. A solution of this problem from an operating and economical point of view is to tie the system together through automatic sectionalizing units which are set to trip at much lower values of current than the substation breaker. The smaller capacity circuits may be conveniently grouped in order that the minimum amount of equipment may be used and yet permit proper protection. This method is very flexible and permits the development of other areas without losing any of the advantages previously obtained.

Automatic Sectionalizing Unit Characteristics

To obtain the desired electrical results as well as to meet other operating and installation features, an automatic sectionalizing unit should have the following characteristics:

1. It should trip on overcurrent.
2. It should reclose after a time delay.
3. It should reclose when load conditions become normal under either stub or multiple feed in either direction.
4. Tripping and time delay adjustments should be independent.
5. Equipment should operate from circuit controlled.
6. Equipment should be suitable for underground service.
7. Accident hazard should be reduced to a minimum.
8. Unit should be strong, simple, and easy to install

The unit shown in Fig. 6 has been designed to meet the above requirements. A considerable number have been installed and are giving the desired operating results. All metal parts receive moisture-resisting treatment, and the coils are impregnated with a moisture-proof compound. All the devices are mounted in a drip-proof, ventilated, steel housing which is self-supporting. The load-indicating resistor is mounted under a drip-proof covering on the top of the steel housing. In this device the control power switch, No. 108, may be operated from the outside without the necessity of opening the door.

The unit is suitable for pole or wall mounting in a manner similar to that used for distribution transformers.

To reduce the accident hazard to a minimum the inclosing case is arranged for connection to the rail return or ground. The arc chute is completely enclosed. The inside of the door is lined with asbestos sheeting, which permits the arc to play against it without danger of grounding to the case on extreme values of overcurrent.

Fig. 7 is a curve obtained from the oscillogram taken while a 600-amp. unit is breaking 6,500 amp. at 3,000 volts on an inductive circuit. The only disturbance noticeable during these tests was the noise during the opening of the circuit and a slight amount of light issuing from the bushing through which the leads passed to the load-indicating resistor. A number of tests were made at various current values, in which the current passed through the unit in each direction. In all tests the case was connected to the opposite polarity to that of the line contactor, No. 172. No tendency to arc to the frame has been observed in any of the units that have been tested. The same type of contactor is used with these units as described under No. 172 of the reclosing feeders. Some idea of the amount of the arc obtained in these units may be gained by comparison with Fig. 4. The latter figure shows the 1,500-amp. contactor breaking over ten times its rating at 550 volts. In the test referred to in Fig. 7, the 600-amp. contactor broke 6,500 amp. at 300 volts. Both circuits were inductive.

If the door had been open during this circuit-breaking test (Fig. 7) it would have been found that the arc would have extended at least 12 in. beyond the case. Tests have been made in view of determining whether the arc chute could be flush with the case and whether the arc could be permitted to discharge into the open air. In such tests it has been found that the arc may be projected as far as 2 ft. beyond the unit. This feature is dangerous to men working or passing in the vicinity of this type of unit.

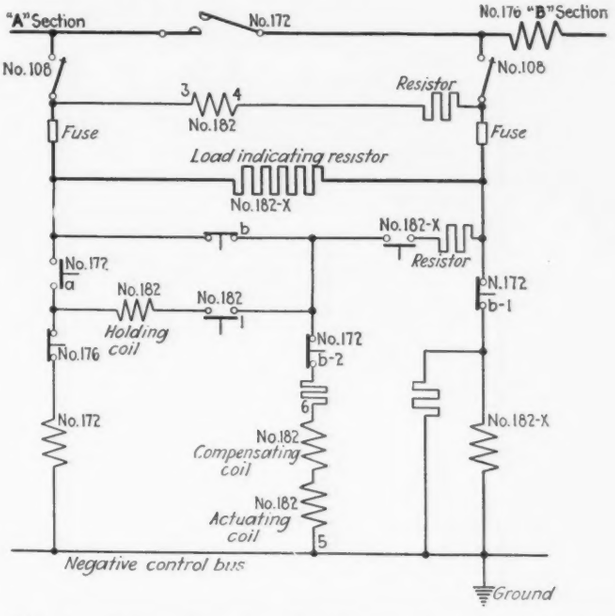


Fig. 8—Elementary circuit diagram of inside of mine sectionalizing and reclosing unit. No. 108 control power switch. No. 172 d.c. line contactor. No. 176 d.c. overcurrent relay. No. 182 d.c. reclosing relay. No. 182-X auxiliary contactor for No. 182. (a) Auxiliary switch is open when main switch is open. (b) Auxiliary switch is closed when main switch is open

When a contactor is inclosed, as in this type of unit, the size of the case is purposely increased to allow for arcking space. Tests have been made when the contactor successively interrupted the circuit a number of times before the door was opened and an examination made of the inside of the unit. No harmful effects were obtained. A thin white smoke sometimes fills the inside of the case after heavy currents are interrupted. This smoke rapidly clears and sometimes results in a light white deposit on the devices. This deposit has no harmful effect and can be readily removed.

Operation of Sectionalizing Unit

Fig. 8 is the elementary wiring diagram of the sectionalizing and reclosing unit. Normally the coil of No. 172 will be energized through the contacts of No. 176 and No. 172-a. Upon the occurrence of overcurrent, No. 172 is tripped by No. 176. After the contactor has opened, the load indicating resistor is inserted in the circuit and a small measuring current is supplied to the load.

The interlocks, No. 172-b-1 and No. 172-b-2, are open while the contactor is closed. They do not close immediately upon the opening of the contactor, but are equipped with a bellows which gives practically the same range of

timing action as No. 102, mentioned under the reclosing feeders. After this time delay has expired, No. 172-b-1 and No. 172-b-2 close. Two actions take place here. In one case the coil of No. 182-X is connected across Section *B*. This is done to determine from which side control power shall be taken. If Section *B* is alive, No. 182-X picks up and closes its "*a*" contact. If Section *B* is dead, then control power is obtained from Section A through the "*b*" contacts of No. 182-X.

Assuming that Section *B* is alive, No. 182-X will be picked up and No. 182-X-a will be closed. The closing of No. 172-b-2 connects the compensating and actuating coils of No. 182 across the source side (Section B). The restraining coil (3-4) of No. 182 is connected across the load-indicating resistor.

It is assumed that short-circuit conditions persist. The restraining coil of No. 182 then receives full operating voltage and holds the contacts of No. 182 open. The action of No. 172-b-2 as mentioned above connects the actuating and compensating coil across the source some time after No. 172 opens. Relay No. 182 is so calibrated as to keep its contacts open when both sets of coils are energized at the same voltage in the above sequence. As the resistance of the load increases, the drop across the load indicating resistor decreases. At the same time the voltage drop across the restraining coil (of No. 182) decreases by the same amount. The voltage across the restraining coil is decreased until it is overpowered by the actuating coil which then closes the contacts of No. 182. This action energizes the coil of No. 172, which closes. Contacts No. 172-b-1 and No. 172-b-2 open immediately upon the closing of No. 172. This operation will drop out No. 182 and No. 182-X.

No. 182 is provided with a holding coil in series with its contacts which keeps these contacts closed when carrying current. A resistor is connected in parallel with the coil of No. 182-X. This resistor acts as a discharge circuit and keeps No. 182-X-a closed long enough for No. 172-a to close and "seal-in" No. 172. When Section B is dead and Section A alive, No. 182-X has no direct part in the sequence.

The application of sectionalizing units to a mine feeder system is shown in Fig. 9. Each section is isolated by its individual sectionalizing unit.

For example, should a short circuit or heavy overload occur at *P*, the units at *M* and *K* will open the circuit at these points and isolate the fault. When the fault at *P* is removed, the units at *M* and *K* will close, thereby restoring service to this section.

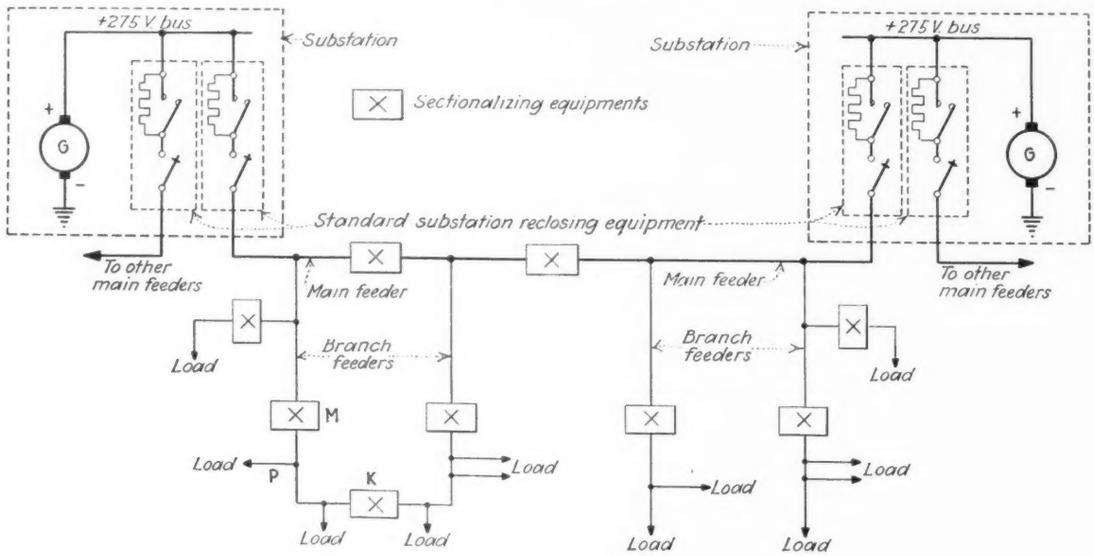


Fig. 9—Diagram showing application of automatic sectionalizing units and reclosing feeders to d.c. mining circuits

The above units will feed in either direction and reclose from either side. Normally they have a voltage range of from 70 to 110 per cent. The overcurrent relay may be adjusted over a range of from 100 to 250 per cent of equipment rating.

Why the Term "Reclosing"

The term "reclosing" is used in connection with these units to bring out the fact that they will pick up load on stub or radial feed. The use of this term has been felt to be necessary, since there are designs of sectionalizing units that are limited to multiple feed only, and which will not pick up any practical load on stub feed. The equipment is reduced to a minimum number of devices by the use of one reclosing relay, No. 182. This relay has one setting, which, in conjunction with the load-indicating resistor, gives operation on stub as well as multiple feed.

With the combination ordinarily employed, the unit will reclose on a maximum load of approximately 175 amp. at 275 volts. On multiple feed, reclosure is obtained when voltage conditions have satisfied the 10 to 9 ratio between the actuating and restraining elements of No. 182. The value of reclosing current on multiple feed depends on several factors, such as the amount and arrangement of the copper in the feeder system, the resistance of the return circuit, and the size and location of the load with respect to the substations. This number of variables makes it difficult to predetermine the reclosing current on multiple feed.

Sectionalizing units of the above type can be correctly applied even to systems having relatively high resistance. The principal precaution to be taken is to select the sections so that proper overcurrent action may be obtained. This will result in the use of equipments

suitable for the load requirements, together with proper settings of the overcurrent relays.

In practically every case it is recommended that reclosing feeders (of the type described at the beginning of this article) be used at the substation. This type of feeder has two separate reclosing relays for stub and multiple feed conditions. Such a combination results in a flexibility and correctness of operation that cannot be obtained by one relay. The principle reason for this recommendation is that there are cases where the resistance of the positive and negative circuit between substations may be relatively high, which, with the use of one reclosing relay, may lead to "pumping" of the line contactor, No. 172.

Assuming in such a system that the load is located near the substation in question and is being supplied from the remote substation: Under these conditions excessive feeder voltage drop is obtained. To use one relay advantageously for stub and multiple feed, and yet pick up a fairly large load, it is necessary either to decrease the relay setting (in terms of feeder voltage) or to increase the kilowatt rating of the load-indicating resistor. The usual procedure is a compromise between the two, which results in a setting in favor of the stub-feed condition. The setting finally obtained for No. 182 (on stub feed) is not high enough (in terms of feeder voltage) for multiple feed, so that, in case of the high-resistance feeder and load location as mentioned above, the feeder breaker is likely to reclose when it should remain open. This usually results in a "pumping" action of No. 172. The most direct solution to be applied to the substation feeder lies in the use of two relays, one for stub and the other for multiple feed. This condition does not exist in the same degree in the case of the sectionalizing units, as they are usually located between stations, a fact that results in the load current being supplied through an appreciable part of the feeder system. This characteristic tends to equalize the load between the adjoining stations, and not throw it entirely on a near-by station.

Putting the above statements in other words, it may be said that, because of the location of sectionalizing units in the feeder system, there is usually a tendency for the load to divide between adjoining stations (on multiple feed), even though the load is situated close to the sectionalizing unit. This same load, situated near a substation, is immediately transferred to that substation when its feeder contactor recloses. Consequently, as a result of the different conditions on the system, different relaying is necessary. These remarks apply principally to multiple feed where the division of the load is the chief consideration. On stub feed no such marked difference exists. Since the units must operate on both stub and multiple feed, both of these features must be considered in the final design and are accordingly incorporated.

Potash Possibilities in Nova Scotia

AT MALAGASH, in Cumberland County, Nova Scotia, is said to be the only property in the British Empire known to contain definite evidences of dry potassium salts, according to *Commerce Reports*. Attention hitherto has been focused chiefly on the development of sale mining in this district, but is now being attracted, also, to the possibilities of finding potash in commercial quantities. Indications of potash are said to be distinct at the 200 level of the salt mine of the Malagash Salt Products Company, but it will be necessary to go 600 to 900 ft. deeper before it will become available in commercial quantities, in the opinion of geologists. The consular report merely states that drilling has been discussed up to the present and not yet begun. It is not clear, therefore, on what evidence the opinion of the geologists is based. A 3-in. band of potash is said to have been found recently in a horizontal bore hole at a distance from the 200 level.

The potash possibilities at Malagash appear to have attracted German interests. It is reported that a conference was held recently in New York between German business men and the legal representatives of the Malagash company. The consular report infers that this conference most likely concerned potash.

As for the salt deposit, it is said that one seam is over 400 ft. thick and runs the entire length of the peninsula. About 400,000,000 tons of salt is within reach of the present workings. Geologists are also said to have estimated that there is at least 60,000,000 tons of 99 per cent pure salt in the 9 square miles of the peninsula under the control of the Malagash company. These same geologists estimate that the peninsula contains also about 300,000,000 tons of salt of a slightly lower grade. The mine is only 2 miles from the wharf and tidewater on Tatamagouche Bay.

Production reports by the company show an increase from 4,550 tons in 1924 to 8,330 tons in 1926. Output is expected to reach 15,000 tons in 1927 and to double that amount next year. The Canadian National Railways recently built a 9-mile branch line to the mine. The fisheries contribute the chief existing market for Malagash salt. Expansion of the Canadian pulp and paper industries, which require large quantities of chemicals made from salt, would naturally cause a growth in demand.

Determination of Palladium and Platinum

O. E. ZVYAGINTZEV (*Ann. Inst. Platine*, 1926; 364-6) has recently discussed the rapid determination of palladium in platinum. In general, the Russian platinum contains about 0.15 per cent of palladium, and its amount may be determined by colorimetric comparison against pure platinum solutions, using potassium iodide as the coloring agent. This, in spite of the fact that both palladium and platinum give brown colorations with this reagent, palladium solutions giving a red-brown color, and platinum dark brown. In testing, 1 per cent solutions are used. They must be slightly acid, but must contain no free chloride or nitric acid. One cubic centimeter of potassium iodide solution (1 to 1,000) is used to 10 c.c. platinum solution, and as the reaction with palladium is slow, final readings are taken only after 30 to 40 minutes. The method is accurate to 0.0002 gram of palladium in 1 gram of platinum at this dilution.

K. L. Graham (*South African Mining and Engineering Journal;* 38, 57-8, 1927) says that common assay methods for platinum metals have yielded wide variations in assays made on Transvaal ores, many results of different assayers being 50 per cent too low. Investigation by the Rand Mines Laboratory has shown that the cause is usually excessive time of contact with sulphuric acid in parting the cupelled buttons, causing partial solution of palladium and rhodium. Removal as soon as visible action has ceased is recommended.

DISCUSSION

Professors and Engineers

THE EDITOR:

Sir: Whether full-time professors of state universities and colleges should indulge in private consulting practice is a question not at all new in this country or elsewhere. Some twenty-five years ago, when I was studying in a European university, the mining and civil engineers of the district sent a petition to the "Ministre de l'Instruction Publique" asking him to restrain the professors of the technical faculties of the country's three universities from competing in private practice with the established engineers. In the petition they argued that the professors were being paid out of the taxes and were therefore on the same footing as other civil servants. They should therefore confine themselves to their students or to state work. If I remember correctly, the "Ministre" took no active steps against the professors. Ten years later, I saw the matter brought up in another country, and with about the same results: nothing happened.

Last year a group of engineers sent a petition on the same matter to the Governor of one of our large Western states. The same arguments were used in this petition. Certain professors and instructors had opened offices for private consulting practice; these professors and instructors were paid out of taxes and were therefore civil servants. The governor had plenty of other troubles at the time and did not wish to add to them by bringing a university hornets' nest about his ears; he did nothing.

Something like this happened: At the monthly dinner of the mining society in the big city, old Jones, the consulting mining engineer, glances out of the corner of his eye at Smith, dean of the mining faculty, who is sitting at the other end of the table. "Damn Smith!" says Jones, "he's just back from reporting on the Bluebird-Orconera. I expected to get that job, but Smith landed it. I grant Smith is intelligent enough, but what does he know about mining? After we graduated we were both together at the 'Mammoth' for a year. Smith then joined the 'U' as mining instructor. For the last eighteen years he has been teaching the same old stuff and has worked up to dean of the faculty. But has he endured enough grind in the mining game to have acquired that 'feel' that will tell him whether or not the old abandoned Bluebird is worth picking up again? He took a week off, made the trip, ran through the mine, took half a dozen samples, and wrote his report. I bet he made a yes, yes-no, no report for which he charged two hundred and fifty. How can I compete? Smith has no office expense, has the university laboratories and stenographers for nothing. He is a member of a great and reputable firm, the university, which is popularly supposed to know 'more than anybody better than anybody.' Added to all this, he receives a neat little salary from the taxpayers to keep him going. How do you want me to compete?

"Here am I, with office rent and part of a stenographer's salary and a lot of other expenses to keep up appearances. Jobs come in sporadically, and I have no salary with which to stem over dull times. How do you expect me to work for the same price as Smith? The Bluebird job was a fifteen-day job—I know all about that mine. It required a heap of sampling and some surveying. It was worth at least $600 and might have led to a permanent retainer as consulting engineer. Smith is a state employee and should stick to teaching, which I hear is no easy job. If Johnson, over there, the state mining engineer, or Murphy, of the State Highways, were to start consulting practice they would soon find themselves in a nice mix-up." And Jones keeps on raving.

After the dinner, Smith comes up to you, and says, "I saw old Jones frothing and faintly heard what he was foaming about. We're old buddies, really, and are in the same trade, mining. I know his old arguments. He is sore about the Bluebird report, to which he thinks he was entitled by divine right. But why the devil shouldn't I take the job? Jones, of course, says I am mainly theoretical and know nothing about mining. I may not know as well as he how to handle a crew of Bohunk miners. I may not know just how many sticks of powder should go into a shot, but I usually know when a mine is good or not. You know perfectly well that most of these consulting jobs are pretty simple and do not require the great amount of time that Jones thinks indispensable; neither do they demand the vast knowledge he thinks he monopolizes. Anyway, the public evidently thinks I am competent. As to underbidding him—well, what of it? I haven't taken unfair advantage of Jones. Without the consulting work I would be underpaid on my salary from the university, and I need the money. Then looking at the matter from a public standpoint, you must agree that this outside work enlarges my views and improves my teaching, and furthermore, provides service to the public at reasonable price.

"As to us professors coming under civil service regulations, well, it hasn't been done yet. If they try to do it, they are going to stir up something. How about the fellows in the other faculties who are full time—law, medicine, and languages, for instance? To suit a few envious consulting engineers, or a few engineers out of jobs, who want to work into something, nobody is going to tackle us professors."

A little later at the Engineers' Club, Simpkins and Ballard, who have heard Jones' ravings, are squabbling over the same matter. They are also old classmates and usually good friends. Ballard is instructor of geology at the university, and Simpkins for four years has been geologist of the Bone Creek Oil Co. But his company having foundered, Simpkins is looking for a job. He says to Ballard, "You old crook, you have just returned, I hear, from the Crazy Woman structure in Wyoming. Apparently you took a week off, four days of which you spent in the train and the rest of the time in a car with field glasses and a hand compass. You then turned down the structure and charged two hundred for your report."

The first part of Simpkins' statement is, of course, slightly exaggerated. But, he goes on, "You should have passed that job on to me. I would have spent eight or ten days in the field, on foot, mind you, and carried a plane table and an alidade. I would have made a decent map with lots of dips and a report not filled up with stratigraphic columns copied out of U. S. G. S. bulletins, and would have cashed five hundred, which I need appallingly. Also, working for those people, I might have landed something permanent. You're a universal geologist of profound wisdom, no doubt, but what the hell do you know about petroleum geology? Why don't you stick to your morons and teach them real geology? You're a civil servant, aren't you?" All this rough talk naturally makes Ballard rather hot and he answers, appropriately, something about the practice of dragging out jobs.

Buxton, once a consulting mining engineer, but now vice-president and general manager of a large mining outfit of whom he used to be adviser, now joins the group. He has lost the suave and conciliating attitude of the consulting engineer and now has acquired the uneuphuistic one of the big mine boss. He breaks in, contempuously,

"You and hard-boiled Jones give me a pain. The majority, but not all, of these professor fellows may not know the ropes of your line of work as well as you do. Their business is mainly teaching engineering, which is not quite the same thing as practicing the profession. They may not have the 'engineering touch' which you fellows have, but they usually have some brains. The problems they are called upon to solve are, eight times out of ten, simple enough for them to solve without great chances of making mistakes. The mines or the oil structures they turn down usually deserve it. In any case, the average public thinks these professors know as much as you men, and, furthermore, it knows that they are usually thoroughly honest. It can't say this of a heap of chaps who are eager to sell their engineering advice.

"Everywhere, as you probably well know, are a lot of half-bakes, not always scrupulous, who call themselves consulting engineers or consulting geologists. Now, how is the average public going to differentiate between these pseudos and you? It can't. You, Simpkins, may be an experienced field geologist and hard-boiled Jones is undoubtedly one of the best mining engineers in the country. But how is everybody to know it? When some fellow is organizing a small mining or oil company, or is interested in knowing about some mining investment offered him, he will go, if it is handy, to the university staff. There he will get fairly good and thoroughly honest service for a low price. Sometimes he will get it for nothing. These things he is not certain of getting elsewhere.

"You and Jones had both better make up your minds that with the decrease of the small companies, and with the increase of the large ones having their own engineering staffs, as well as with the growing hordes of technical professors and instructors, the consulting engineer is taking the road followed by a certain large flightless bird now extinct."

Jones, Simpkins, and Ballard are, of course, edified, at the end of this tirade, but, for egotistical reasons, convinced not in the slightest degree.

M. J. Hopkins.

Rolling Bay, Bainbridge Island,
State of Washington.

Flotation Nomenclature

The Editor:

Sir—The editorial on flotation nomenclature in the issue of Dec. 3 was particularly important to me, since it linked up with a problem we have not been able to entirely solve. As in the case of every new process, terms have to be invented, and, as is also frequently the case, there is a looseness in the nomenclature until a point of stability is reached. To describe a simple flotation operation for lifting only one mineral or for lifting a group of minerals together, there are in use the terms "straight flotation," "bulk flotation," and "collective flotation." Another term which might be used would be "single flotation" to distinguish it from "multiple flotation," which is applied to the separation of two or more sulphides from one another. For this "multiple" flotation, usage has at various times adopted the terms "selective flotation," "preferential flotation," and "differential flotation."

In revising the "Text Book of Ore Dressing," Professor Richards and I decided that "differential flotation" was perhaps the most common term, and we therefore adopted it. It seems significant that Professor Taggart has likewise adopted this term in his recently issued "Handbook of Ore Dressing." I have not made any careful check on the literature, but it is my impression that such a check would show a preference by writers for the term "differential" flotation, although some writers use "selective" flotation and "preferential" flotation.

Technical terms are adopted in many cases not from the logic of their meaning from the standpoint of pure English, but by what develops as a custom. If, therefore, it should appear that "differential" flotation has become the most common term today to denote the multiple process, then it would be unwise to try to change it, even though by strict definition some other term should be proved to be more suitable.

To express the single operation of flotation, Professor Taggart is to be credited with the first use of the word "collective" flotation in an ore-dressing book. This term does not appear to be commonly adopted so far, but with the help of a book which will be so widely used as Professor Taggart's, this term should become common. My first thought was that it was not quite so expressive as the term "straight" flotation, which I have commonly used when I meant a single operation, but I can see no strong objection to it.

After all, the purpose of English is to convey ideas, and if the transmitter and receiver talk a common language, then no difficulty is found in the transmission; but if either employs different terms for expressing the same thing, there is bound to be confusion. It therefore seems extremely desirable that some general action be taken to arrive at a common understanding, and *Engineering and Mining Journal* is to be congratulated on having started the movement. I believe that the American Institute of Mining and Metallurgical Engineers cannot go on record as definitely establishing standards, but there is an easy way out of it through the Milling Committee of the Institute. This committee could study the matter and make a formal report with definite recommendations, which I understand lies fully within its province. This report would naturally follow after full discussion in *Mining Journal* and after opinions had been gained from other sources. Charles E. Locke.

Cambridge, Mass.

Activities of the Northwest Mining Association

THE EDITOR:

Sir—The Editor of *Engineering and Mining Journal* writes: "An increasing interest in co-operative professional and trade activities has become manifest in the mining industry, and information concerning your purposes and plans will be appropriate and timely for our columns." Taking that as an invitation, the following outline of the history and program of the Northwest Mining Association has been prepared:

The association was established on Aug. 20, 1895. The name first used was "Northwest Miners' Association," but when the formal organization was completed a few months later the present title was adopted. Mining men from the four Northwest states and British Columbia attended the organization meeting, and selected Graham B. Dennis as their first president and L. K. Armstrong as their first secretary.

On Nov. 14, 1927, a banquet was held at the Spokane Hotel to commemorate the thirty-second anniversary of the association. Seven of the original members attended this banquet, including P. A. O'Farrell, who came across the continent to be the principal speaker. Mr. O'Farrell was on the staff of F. Augustus Heinze at Butte when the association was organized. I had the pleasure of interviewing Mr. O'Farrell in New York early in November and delivering personally the invitation to address the association at its thirty-third annual banquet. Mr. O'Farrell recently wrote:

"I have attended many a mining congress, but never before have I found so much optimism and enthusiasm. . . . Pioneers of two generations talked of the past and visualized the future. . . . They told of new and marvelous gold discoveries in the fastnesses of Montana's mountains . . . of wonderful gold placers of the Liard and the Yukon . . . of very rich galena mines in Idaho, in Montana and in the Finlay Valley of British Columbia."

It was my misfortune to be detained in the East on business, but mining men who attended the banquet expressed themselves as amazed at the renewed interest in Northwestern mining which it denoted.

This banquet, on the eve of the association's fiscal year, has given a great impetus toward the program laid out for 1928, which will be initiated with the annual convention to be held in Spokane the week of Feb. 27 and March 3.

The major activities of the association for 1928 may therefore be said to include:

1.—Holding of a spring convention designed as a forerunner to an international convention in 1929.

2.—Compilation and eventual publication of a Northwest Mines Handbook, similar to that which was issued under the auspices of the association in 1918, and which is still regarded as a valuable reference work despite the fact it is ten years out of date.

3.—Co-operation with other associations in a survey of natural resources, with such state and governmental assistance as may be procured.

4.—Co-ordination of efforts to rid the industry of its faker fringe, so that legitimate mining need no longer be embarrassed by the activities of unscrupulous parasites.

Though the foregoing program is that upon which most of our attention will be centered during 1928, we shall continue to demand better governmental appropriations for the Bureau of Mines and the Geological Survey. The program of the Northwest Mining Association in this particular has been adopted in full by the American Mining Congress, and, this being the fact, we feel that the national organization should now assume the leadership, receiving the cordial support and co-operation of those bodies which are more restricted in their territorial scope.

The Northwest Mining Association will also continue its efforts for better transportation facilities, including highway, rail, and water.

In the legislative field the association will continue its fight for more reasonable taxation, for fewer restrictions on prospectors and operators, and against drastic blue-sky legislation, of the type which prevents the marketing of securities honestly designed to forward the economic development of the West.

The Northwest Mining Association has encouraged the formation of local mining clubs. More than 500 Americans crossed the line last year on the occasion of a mining convention in Nelson, B. C.

At the beginning of 1925, the association, acting through F. C. Bailey, then secretary, purchased the semi-monthly journal *Mining Truth,* which has since been published as the association's official paper. The previous owners had not been able to make the publication a paying venture, but rather than permit its sale to a publication in a distant city, which would have deprived the Northwest of its own regional mining paper, the association for the second time undertook to produce a mining journal representative of the Northwest. When the association was organized, in 1895, the old *Northwest Mining News,* published by L. K. Armstrong, was renamed *Mining,* and continued as the association's paper for a number of years. When *Mining Truth* was taken over by the association, Leon Starmont, who had demonstrated his sympathy with the mining industry as editor of the *Seattle Star* and the *Spokane Press,* was engaged as managing editor. Two years later Secretary Bailey resigned and Mr. Starmont succeeded him. Mr. Armstrong, the association's first secretary and editor of its first publication, is now associate editor of *Mining Truth.* Two small mining publications have been absorbed by *Mining Truth* since the association took it over.

One important phase of the association's work is its information service, covering mining activities in Montana, Idaho, Washington, Oregon, British Columbia, Alaska, and the Yukon. The mails bring an ever-increasing number of inquiries, which the association answers with facts, but never with advice except in the rare instances in which public policy demands that warnings be given about specific promotions. At least four properties now listed as producers owe their regeneration to the work of the association in the last three years, and probably a dozen others nearing the production stage can be pointed out as definite examples of the ability of the organization to bring owners of mining properties and possessors of capital together.

The association has often been asked to establish a department for trading in mining properties, but this has not been done, owing to the feeling that it would interfere with private businesses already engaged in that activity.

Active direction of the association is in the hands of an executive committee of seven, elected without regard

to geographical distribution by the membership at large. There are seven committees of five members each—legislative, taxation, transportation, publication, membership, natural resources, and a vigilance committee, the function of the last-named being to keep an eye on doubtful promotions and manufactured "booms." There is also a general convention committee of fifteen members. These committees added to the executive committee make 57 members of the association who are elected or delegated to carry on its actual work, exclusive of the business staff of *Mining Truth.*

Spokane, Wash. CHARLES H. GOODSELL,
President, Northwest Mining Association.

* * * *

Tramp Iron and Crushers

THE EDITOR:

Sir—In your issue of Dec. 3 appears an interesting article on swing-hammer crushers, by W. T. W. Miller, on the third page of which appears the caption "Tramp Iron Dangerous." Although one must admit that tramp iron, or any hard, unbreakable object fed to any type of crusher or pulverizer is undesirable, yet, in my experience, swing-hammer pulverizers and crushers are less likely to be injured by tramp iron than is any other type of rock breaker or pulverizer. As an instance of this I will cite a Williams No. 3 "Worldbeater," or "Two in One," as it was sometimes called, which was installed some years ago in a local plant for crushing barite. This machine was placed in a pit formerly occupied by a 9x13 jaw crusher so that it could be fed from the ground level; the fines were taken from it and deposited in a bin by a chain and bucket elevator. A 20-hp. constant-speed motor furnished the power.

The barite was "run of mine," and ranged from lumps as large as would pass the feed mouth of the hammer mill to what might be termed "fines." On a test, using screened material only, feeding the larger material which had been passed over a 4-in. round aperture and up to blocks of over 100 lb. weight, the crusher handled at the rate of 12.5 tons per hour. In my opinion, it would have handled more had it been supplied with a mechanical feeder; but, as it was fed by hand by three laborers working from the screened stockpile, 12.5 tons was all that could be fed in an hour. Screen analysis of the product showed:

	Per Cent
On 6 mesh	11.9
Through 6 on 10 mesh	9.0
Through 10 on 20 mesh	8.1
Through 20 on 30 mesh	5.6
Through 30 on 40 mesh	5.2
Through 40 on 60 mesh	14.4
Through 60 on 100 mesh	17.0
Through 100 on 150 mesh	7.4
Through 150 on 200 mesh	6.6
Through 200 mesh	14.8

This will indicate that it was set for fine pulverizing. About a week after the machinery had been put in operation the superintendent of the plant noticed a bolt about 6 in. long on the ground near the crusher, and stooped to pick it up. It was hot enough to burn his fingers. Examination showed that it was not a part of the hammer mill, but was a bit of tramp iron that had been thrown out of the mill by the hammers. Some time afterward, one of the laborers who fed the crusher came to the superintendent and stated that "there do be something the matter with the mill," and questions elicited the statement that "she seems to run all right but she sounds like a Ford." The mill was shut down and a dozen pieces of tramp iron were recovered, ranging from an axe head to a coupling pin and some 2-in. nuts. These were tossed into an empty barrel near by, and the mill was examined, but no trace of damage could be found, so it was set to work again. This condition repeated itself many times, and I heard the superintendent, when showing the mill to visitors, state that it "filled a long-felt want," that it was unbreakable, that "two and a half barrels of tramp iron had been removed from the mill or had been thrown out of the mill by the operation of the hammers," and that "the mill had not been damaged a particle, in any way, by it."

Now, I think all will agree with me that a competent superintendent, finding that tramp iron was being fed in such quantities to a mill of this type, would have taken means to remove such material from the ore before it was fed to the mill. No such precaution was taken, and other recommendations made regarding this portion of the installation were ignored, and still the mill hummed merrily on its way, reducing the barite to "tube-mill feed" for fine grinding; until one day there came a roar from the operating department—the mill was out of commission. An examination showed that the bearings were in bad condition, the shaft cut and scored, and a general overhauling was necessary.

Demands were made on the maker of the device and, after investigation, he refused to replace the worn parts without payment for the new parts to be supplied by him. The superintendent "roared" some more, cursed the machine as being inefficient, poorly designed, expensive to maintain, and finally removed it and put back the jaw crusher, which it had formerly replaced and which, at the cost of the same amount of labor and horsepower, would only reduce two-thirds as much rock per hour to sizes from $1\frac{1}{2}$ in. down.

As stated, this hammer mill had been operated in a pit below floor line, from which there were but three openings—one to feed the mill, and two through which the elevator chains extended to take the crushed material away from it. The mill therefore was obliged to run (450 r.p.m.) in a small, inclosed space, which was literally filled with the fine grit produced by the operation. This grit eventually found its way into the bearings and caused the trouble. Had the mill been installed in such a manner that the dust and grit could have escaped, and had an efficient system been put in to remove the crushed material, in place of the single strand of chain with malleable buckets, the mill would undoubtedly have been giving excellent service today. Tramp iron did not injure it in any way, but continuous operation when inclosed in a grit-filled space eventually broke it down. It could have been repaired at small expense and would then have been as good as when installed; but, because the makers refused to do this for nothing, the machine was condemned.

From my personal observation of this mill I would not hesitate to recommend it to anyone for a similar work—crushing and pulverizing at one operation. Several times since the above-related experience I have recommended similar mills for similar work and have been informed that "it was no good." Many a good man and many a good machine have been condemned because they were never given a chance to make good.

San Francisco. G. L. HOLMES.

NEWS OF THE WEEK

Summary

LETTERS reaching members of Congress from mining states indicate wide movement to take advantage of favorable year to obtain Congressional consideration of the needs of the industry.

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Subsequent drilling proves presence of two orebodies predicted by a survey made of 480 acres by a field party of the Physical Exploration Corporation for the Vinegar Hill Zinc Company in the Platteville district of Wisconsin.

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Northern Transvaal (Messina) Copper Exploration, Ltd., in the Zoutspansberg district of the Transvaal, South Africa, encounters radioactive ore in the course of shaft sinking operations.

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As a result of the shutting down of the Monte Cristo mine and the recent abandonment of the Ballas property at Ajo, the Julian interests have now stopped all their operations in Arizona.

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W. A. Clark interests take over the Otisco and O'Brien claims in the south-central portion of Butte, Mont., after the Lewisohn interests give up their lease and option.

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Sacramento Hill ores of the Copper Queen branch of Phelps Dodge Corporation may soon be mined by the branch-raise caving system, according to a recent report.

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Humboldt Copper Company, last of the Keweenaw Copper Company's subsidiaries, is dissolved and its assets purchased by the parent company.

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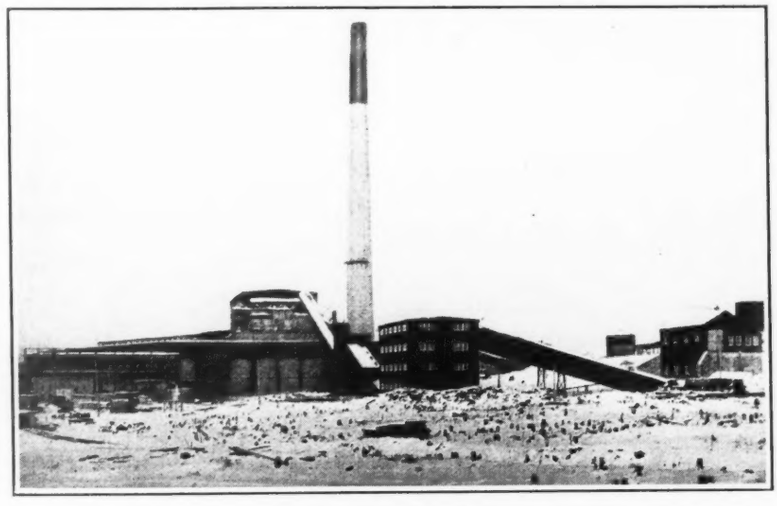
Recent strike in Sunnyside, in the eastern end of the Oatman district, is considered one of the most important in recent years.



The Noranda smelter

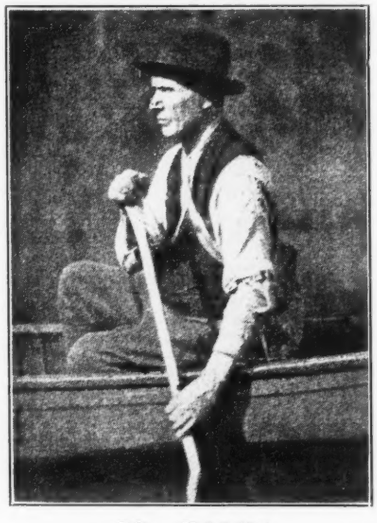
Ceremonies Mark Pouring of First Copper at Noranda Smelter

Officials of Company and a Number of Guests Enthusiastically Witness Initial Production at 4 o'Clock in the Morning on Dec. 16

POURING of the first copper at the new smelter of Noranda Mines, Ltd., at Rouyn, Quebec, took place at 4 o'clock in the morning on Dec. 16. Ceremonies appropriate to the occasion were held and participated in by a number of the officials of the company and guests, including J. Y. Murdoch, president of the company; Messrs. Thompson and Chadbourne, of New York, managing directors and promotors of the original syndicate which bought the property; Ed. Horne, the discoverer, and members of the Tremoy Lake Syndicate which financed him; L. K. Fletcher, field engineer for Noranda Mines, who had charge of the property until 1925; A. E. Wheeler, who designed the smelter, and F. Snow his assistant; F. M. Connell and J. H. C. Waite, of Toronto; and Ernest Hibbert, the manager, and his staff, who have brought the enterprise to its present stage.

The blowing in of the Noranda smelter marks an important event in the history of mining in eastern Canada, as it is the first copper smelter in Canada to be built east of British Columbia. The plant has a rated capacity of 1,000 tons a day from two separate units rated at 500 tons each. The ore is, however, an easy one to treat, so that the rated capacity will probably be considerably exceeded.

Although the Rouyn camp is only a few years old, interest in the district dates back much farther, as it was in 1911 that Ed. Horne, a veteran prospector, made his first trip into that section. He was impressed with the possibilities, but staked no ground, as the district was inaccessible and the only means of transportation was by canoe.



ED. HORNE

In 1914 he returned, and made a discovery on the ground now owned by the Noranda. He again visited the locality in 1917, and made another discovery at the place where the present No. 2 shaft was sunk. Up to this time, no staking had been done, as conditions regarding transportation had not changed. In 1920, Horne, still impressed with the district, formed the Tremoy Lake Prospecting Syndicate with 100 syndicate shares, which were largely taken up by people in Liskeard and Haileybury. With this money, he returned to Rouyn, and staked 70 acres covering the ground on which the No. 1 and No. 2 Horne shafts were later sunk. Considerable prospecting was done in 1921, and a further 160 acres was staked. Results were considered very promising, and in the early part of 1922 400 acres more were taken up.

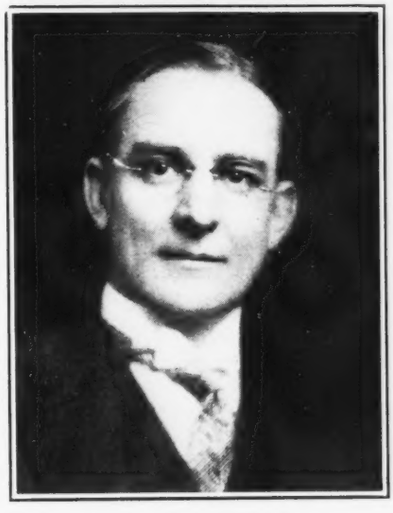
Horne's discoveries consisted of an iron gossan, containing iron pyrite and pyrrhotite and assaying $2 to $11 in gold, but with little or no copper. On account of the distance from a railroad, the difficulties of transportation, and the fact that the nearest properties of known importance were in Kirkland, 50 miles away, the established companies did not display much interest in the district. In the fall of 1922, however, a quartz-gold discovery was made by another prospector named Powell. This caused a rush to the district, and practically the whole of Rouyn Township, embracing 100 square miles, as well as parts of surrounding townships, was staked.

The Horne group was optioned to the Thompson-Chadbourne syndicate, of New York, which was subsequently incorporated as Noranda Mines, Ltd. Up to this time, the Tremoy Lake Syndicate had spent approximately $5,000, and for this they eventually received $280,000 in cash and a one-tenth interest in the mine. The interest was subsequently converted into shares which now have a market value of $3,000,000, so that each syndicate share which represented $50 is worth $32,800.

Original Discoveries Neglected in Early Operations

For the first year that the property was under option to Thompson-Chadbourne practically no attention was paid to the original discoveries, work being confined to the Powell and Chadbourne gold properties. Results on these, however, were rather disappointing, and, as a last resort, in the fall of 1923, a diamond drill was started on Horne's original discovery. This hole was the beginning of the company's success, as it cut 131 ft. of solid sulphides, averaging $4.36 in gold and 8.23 per cent copper, a much higher value than had ever been found in similar types of ore in Canada. The entire opinion regarding the district changed almost overnight, a new basis of value was established, and further prospecting in the entire section was immediately concentrated on copper, with the result that within a comparatively short time copper was found over a wide area.

Within a period of four years, a new town has grown out of the wilderness, two railroad lines have been built to serve the camp, several important mines have been developed, and the 1,000 ton



J. Y. MURDOCH
President of Noranda Mines, Ltd.

Noranda smelter, with its 427-ft. stack, which provides a landmark for hundreds of square miles of country, has been completed, and is now in operation.

The smelter is designed to handle both mine and custom ore, separate receiving bins, crushing units, conveyors, and automatic samplers being provided. The ore is crushed to ¼ in. and delivered to 34 steel storage bins having a total capacity of 10,000 tons. From the bins the ore is delivered to eight Wedge roasters, 25 ft. in diameter and 27 ft. high. The calcine is delivered to two reverberatory furnaces, 100 ft. long and 25 ft. wide. The matte containing about 35 per cent copper goes to two converters of the Peirce-Smith horizontal type, 12 ft. in diameter and 26 ft. long. Firing is with pulverized coal, and a feature of the plant is the use of recuperators, used to transfer the waste heat in the furnace gases to the air used in the combustion of the fuel. The Cottrell system is also used, for dust precipitation. Kenneth Williams is smelter superintendent.

For the time being only the first unit will be operated, its construction having been pushed ahead of the other. After a few weeks, by which time it will be seen if any weaknesses develop in this unit, the second will be completed. Eventually, the second unit will run largely on outside ores, but until these are received in sufficient quantities, both units will operate on Horne ore. No difficulty is expected in maintaining a grade of at least 10 per cent copper carrying $5 to $6 in gold, so that initial production will be at least 3,000,000 lb. of copper a month. The copper will be marketed by the British Metal Corporation.

The Noranda Mines also controls the Waite-Montgomery and the Aldermac properties, the ores of which will need to be concentrated. A concentrator may have to be built at the Aldermac, which is 12 miles from the Horne, but a concentrator is now under construction at Noranda to treat the Waite ore and such ore at the Horne property that requires concentrating.

The company's position in regard to flux is particularly favorable, as there are large tonnages of high-silica ore immediately adjoining some of the principal orebodies. This ore will run about 2 per cent copper and $1.75 to $2 in gold. At present 1,000,000 tons of ore is developed above the 300 level, having a gross value of $25,000,000. During the past summer additional bodies of high-grade ore were found on the surface, but these have not yet been sufficiently developed to permit an estimate of ore reserves. Diamond drilling has also shown the vertical extension of some of the high-grade bodies to a depth of a least 600 ft., but these results have not been considered in the estimates. The main shaft is down below the 500 level, and new levels are being opened at 400 and 500 ft. Some of the high-grade orebodies should be cut on these lower levels within the period of the next two weeks.

Shaft sinking has again been started, the present objective being 800 ft. During the past year, shortage of power, the big construction program, and the necessity of putting the mine in condition for production have held back mine development, but with all these handicaps out of the way, mine development will be carried on at a much faster rate, and the ore reserves should show a big increase in the near future.

The company is capitalized at 2,250,000 shares of no par value and also has outstanding $3,000,000 of bonds owned by the Hollinger interests. It is believed that profits for 1928 should be sufficient to retire the bonds and still leave a substantial surplus. Control of the company now lies in Canada, and it is expected that early in 1928 the New York office will be moved to Toronto, and that several of the present New York directors will undoubtedly soon be replaced by Canadians.

President Murdoch An Outstanding Figure

Without question, one of the most outstanding figures of the whole organization is the president, J. Y. Murdoch, a member of the legal firm of Holden & Murdoch, Toronto. His original appointment was largely a matter of business convenience, in order to have a legal head office in Ontario. He retused, however, to be content with this, and developed such an ability for organization that he became practically indispensable; with N. A. Timmins, he now controls the company.

The Noranda starts off under good auspices. It has one of the most complete and up-to-date plants in the country, is well financed, well managed, has ample ore reserves, a large supply of low-cost power, and should be one of the lowest cost copper producers on the continent. The company also has its own townsite, where provision will be made to take care of all its employees.

Several Montana Properties Under New Control

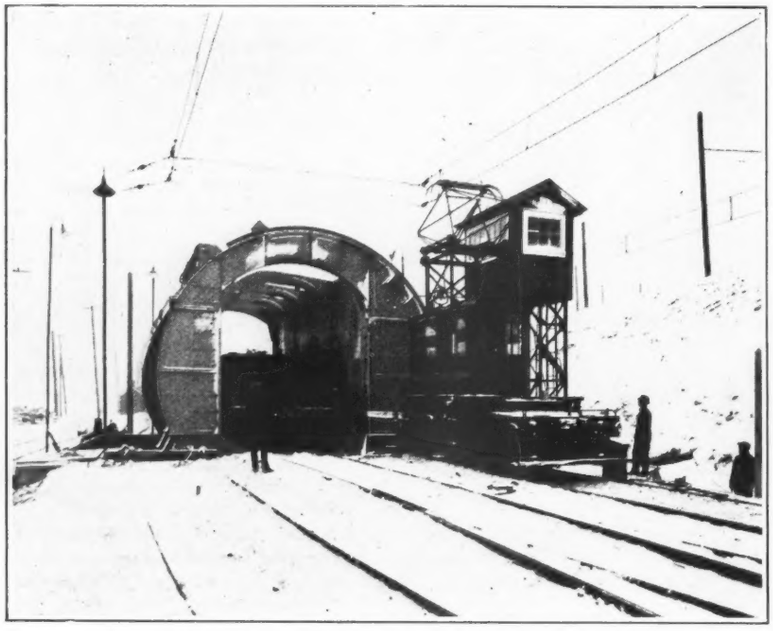
W. A. Clark Interests Take Over Otisco and O'Brien Claims—Butte & Duluth Holdings Sold by Sheriff—Butte & Plutus Tracts Bought

ON DEC. 1 the Lewisohn interests gave up their lease and option on the Otisco and O'Brien claims, which they were operating in the south-central portion of Butte, Mont. Development work has been confined to orebodies above the 300 level. When it was known that the Lewisohns had given up their option three large mining interests made proposals to assume control of the property, it being finally taken over by the W. A. Clark interests, who expect to further develop the property and ship ore to their mill at Timber Butte. The property adjoins the claims of the Butte Copper & Zinc Company on the east and is about 1,600 ft. west of the Belmont mine of the Anaconda Copper Mining Company. The Otisco shaft is down 400 ft. and is equipped to sink to a depth of 1,000 ft.

The property of the Butte & Duluth Mining Company has been sold by the sheriff to Paul Hudtloff, to whom most of the creditors of the company had assigned their claims. The price paid was $47,172.75; the company once had an appraised valuation of over $1,000,000. The property is located in the Columbia Gardens district of Butte, and was formerly operated by Captain A. B. Wolvin and associates. A number of years ago a leaching plant was installed at the Butte & Duluth to treat the oxidized copper ore mined by the company; subsequently, the machinery was dismantled and sold. Mr. Hudtloff, the present owner, was non-committal as to whether or not operations will be resumed at the property.

E. M. Norris and D. J. McGrath recently purchased at sheriff's sale the eight mining claims of the Butte & Plutus Mining Company, the purchase price being $4,721.25, to satisfy a judgment of $4,500 rendered in 1922.

The Anaconda Copper Mining Company has made some important changes in the crushing plant of its copper concentrator at the Washoe smelter. A rotary car dumper of one-car capacity has been installed, removing the necessity of using hopper bottomed cars. The cars are pushed on to the dumper by levers extending from the sides of electric locomotives operating on tracks on either side of that on which the cars are pushed.



New rotary car dumper at Washoe smelter

A five-foot conveyor belt has been installed to deliver the ore from the cars to the gyratory crusher, the belt being about 200 ft. from center to center. After the ore passes through the gyratory, it is crushed by two Symons cone crushers, and then passes to a belt conveyor which delivers the finely crushed ore to a huge storage bin with capacity of 14,000 tons; this bin is in the main concentrator building. In its journey on the conveyor, the ore passes beneath three sets of electric magnets, these magnets removing tramp iron and steel. Wood and other foreign substances are removed by men stationed along the first conveyor belt. The rotary car unloader, which is shown in the above view, has a capacity of 1,000 tons an hour.

Manganiferous Iron Company Leases Mangan Mine

The Manganiferous Iron Company has taken an assignment of a lease from the Mangan Iron & Steel Company on the Mangan No. 1 mine, near Ironton, on the Cuyuna range. This property adjoins the Louise mine, which has been operated for the last four years by the Manganiferous Iron Company; arrangements have been made to permit hoisting of the Mangan ore through the Louise shaft.

The Mangan mine was first opened in 1916 by the Mangan Iron & Steel Company, which shipped 135,000 tons of manganiferous iron ore from the property until it was closed down in 1920. It has since been idle. The mine was opened up by shaft to a depth of 160 ft. The State Tax Commission estimated a reserve of 243,000 tons of ore remaining.

An option for a lease on the Hillcrest mine has also been taken by the company. The northern portion of the property is being check-drilled for manganese.

Geophysical Methods Successful in Wisconsin

A field party of Physical Exploration Corporation (Mason, Slichter & Hay) recently completed a geophysical survey of 480 acres for the Vinegar Hill Zinc Company in the Platteville district of Wisconsin. As a result of the work, two orebodies, in agreement with the predictions, have been proved by drilling. Electrical methods were utilized in this district several years ago without practical results, and this is apparently the first commercial success of such methods of exploration in the district. Earlier in the season Mason, Slichter & Hay carried on extensive research studies in this locality, which led to the practical application of methods developed during that investigation. The ore found consisted of sphalerite and galena associated with marcasite.

New Chicago Purchases Vantage No. 1 Mine

The New Chicago Mines Corporation, in the Joplin-Miami field, has purchased the No. 1 mine of the Vantage Mining Company, near Picher, Okla. The consideration was semi-officially reported at slightly less than $100,000.

It is the plan of the purchasing company to convert the mill at the Vantage No. 1 mine into a tailing mill, while the No. 4 mill of the New Chicago, which has been running tailings for the Premier mine, which it also owns, will be changed to handle mine ore. The Vantage No. 1 mine has been one of the best in the field and has paid more than a million dollars in dividends. It has been managed for a number of years by O. A. Sneed.

Keweenaw Copper Company Purchases Humboldt Assets

State of Michigan and Gogebic County to Institute Suit Against Victoria Company

THE Humboldt Copper Company, last of the Keweenaw Copper Company's subsidiaries, was recently dissolved and its assets were purchased by the parent company. The companies previously dissolved and taken over by Keweenaw were the Washington, Phoenix, and Meadow. Keweenaw Copper's future course is largely dependent on what Calumet & Hecla finds in the Cliff and Phoenix properties and contiguous lands in Keweenaw County. Keweenaw now has more than a quarter of a million cash on hand and valuable timber lands worth at least $300,000. It also receives some income from the Keweenaw Central Railroad and land options to Calumet & Hecla. Keweenaw is in good condition financially, and in addition to lands optioned to Calumet & Hecla the company owns 26,500 acres.

A suit to compel the Victoria Copper Mining Company of the Michigan copper district to establish a permanent level on Lake Gogebic will soon be instituted by Gogebic County and the State of Michigan. The company maintains a dam in the Ontonagon River at the outlet of the lake, and fluctuation of the lake level, it is claimed, is detrimental to summer resort and summer home sites along the lake. The state claims a right in all meandering, navigable, and running streams, and for this reason is interested in the final determination of the question affecting both the lake and river. It is expected that the suit will result in a judicial determination of the respective rights of the mining company, the county, and the state. An assistant in the Attorney General's office will co-operate with the officials of Gogebic County in assembling the facts to incorporate in the bill of complaint. The question of determining the lake level has been discussed for several years, but this is the first time an effort has been made to take the matter into court.

At the Copper Range Company's mines, more than the usual amount of opening work is being done in Champion. Sinking is proceeding in all three operating shafts, Nos. 1, 3, and 4. In the south end of the property, the richest part, Champion is five or six years ahead of actual requirements for stoping, although mining is carried on more or less in levels which are being extended. Although the general tenor of the ground is not as rich as it was a decade ago, yield is well maintained. Champion, contrary to a widespread impression, never was a "rich" mine in regular, heavy mineralization. It always has been necessary to reject a large percentage of vein rock to keep the yield high, the waste being used for filling purposes in the mine openings. No. 2 shaft is idle. Reopening will depend on improvement of ground at depth as determined through other shafts. At Trimountain, where little development is under way, considerable stoping is being done in No. 4 shaft territory and some in No. 3 through No. 2, the only unit now operating. The same procedure is being followed in Baltic, where stoping is proceeding throughout the mine through No. 3 shaft.

Mohawk's cost per pound of copper laid down in New York approximates 8c. This includes taxes, but excludes depletion and depreciation. In both costs and production, Mohawk is now at the peak of its career. November output of refined copper was equal to that of October, production being at the rate of better than 20,000,000 lb. per year.

Considerable mass copper is being mined in all three shafts of Ahmeek, the rich amygdaloid producer of the Calumet & Hecla group. The mass fissure vein in No. 2 is yielding large slabs of metal, and about 30,000 lb. per month is being hoisted from each of the other two shafts, Nos. 3 and 4.

Though Seneca remains idle and there appears to be no prospect of reopening, at least in the near future, the mine is being kept free of water. Electric pumps continue in operation in No. 1 shaft, into which the water drains.

Radioactive Ore Found in the Transvaal

In the course of shaft-sinking operations on the property of the Northern Transvaal (Messina) Copper Exploration, Ltd., in the Zoutspansberg district of the Transvaal, Africa, an unusual occurrence of radioactive ore was recently encountered. No. 5 shaft, in which the ore was found and which is shown in the accompanying photograph, is being sunk to develop the copper deposits of the property.

No. 5 shaft of the Northern Transvaal (Messina) Copper Exploration, Ltd.

Strike in Oatman District Considered Important

Sacramento Hill Ore May Be Mined by New System—Tonto Company Shipping Quicksilver

THE recent strike in Sunnyside, in the eastern end of the Oatman district, is considered one of the most important in recent years. The main vein, about 45 ft. wide, has a pay streak sampling high in gold. The matrix is the camp's familiar quartz-calcite. Whether the big vein has milling possibilities has yet to be determined. It has a dip of about 35 deg. and its material shows considerable shattering.

Reports are to the effect that the Sacramento Hill ores of the Copper Queen branch of Phelps Dodge Corporation may, in the near future, be mined by the branch-raise caving system, similar to that now in use at the Inspiration Consolidated and Miami Copper properties. The ores are at present being mined by steam shovels.

The first shipment of quicksilver to go out from the Tonto Mining Company was made recently. The property is in northern Gila County, above the Roosevelt Dam. Its furnace has been in operation about a week, and it is expected that from 25 to 50 tons of ore will be put through daily. There is a power house at the camp, and everything but the furnace is operated electrically. Crude oil is burned in the furnace.

John J. Higgins, former owner of the Higgins group of claims, now the property of Phelps Dodge Corporation, has announced the formation of a company to spend $200,000 in developing claims formerly owned by the Copper Queen Extension Mining Company. These claims are about 2,500 ft. south of the Shattuck shaft in the Warren district.

Present Session of Congress to Hear From Mining Industry

By Paul Wooton
Special Washington Correspondent

CONGRESS is going to hear from the mining industry at some length at the present session. Many in the industry seem to have determined that the federal government should be as considerate to mining as it is to certain other activities, particularly since the central government is in a position to perform various services that are much needed at this time. Judging from the letters reaching members of Congress from mining states, there is a far-flung movement in progress to take advantage of a very favorable year to get the ear of Congress. National legislators are unusually sensitive to the desires of the public in a presidential year. Plans already are being laid to take advantage of this opportunity to secure some commitments on behalf of mining.

The difficulties which have been experienced in getting a small appropriation for the investigation of geophysical prospecting seem to have aroused mining men to the lack of consideration they are receiving in Washington. It has been apparent for more than two years that the industry generally has been anxious to have a survey made of that subject, but all that has been done has been at the expense of other mineral investigations when the Bureau of Mines reallotted a few hundred dollars for the purpose. Although this was a relatively small matter, it presented a situation where the government was the only agency that could render that particular service. Failure to respond to that small demand has done much to arouse the feeling that the mining industry must have the consideration which is its due. This question is to be discussed at an early meeting of the Mines and Mining Committee of the Senate.

More Research Work Demanded

The principal demand is for more research. Responsive to that desire Senator Smoot, one of the majority leaders and chairman of the Finance Committee, has introduced a bill proposing the erection of a $1,000,000 experiment station at Salt Lake City. His colleague, Senator King, prominent among the minority members, has a bill intended to accomplish the same purpose as that of Senator Smoot's, but by a different legislative route.

Senator Oddie is seeking to amend the Commerce Department appropriation bill so as to double the amount of money available to the experiment stations established under the Foster act. In addition, he is proposing that two more stations be Fosterized.

As this is written the Commerce bill has not been reported by the House committee. Although some cut may be made in the increases allowed mining activities in the budget, the prospects are that the law will carry as much as, if not more than, the budget allowed.

Introduction of the bills by the Utah Senators looking to the establishment of a large central mining experiment station at Salt Lake City has given rise to the fear that this will mean the abandonment of at least some of the small experiment stations. Should Congress decide to establish the Salt Lake station it is believed that it would impair in no way the status of the small stations, but, in fact, would make them more necessary. It is regarded as significant that so many persons in the industry are quick to come forward with vigorous protests when curtailment of the activities of the experiment stations is threatened.

Small Stations Not Affected

Two years ago the Reynders advisory committee contended that certain advantages could be gained by abolishing the smaller stations. The idea did not meet with favor in the department, nor on Capitol Hill, because it is felt in those quarters that the small stations supply the element of close contact with the mining regions. Although the small stations have at their disposal only $23,500 per year, they do an immense amount of local service work, in addition to their research on problems of regional interest. It is admitted that these small stations cannot undertake major problems, but the need for research on local problems is so great that their programs for years to come are full.

The Smoot bill authorizes the Secretary of the Treasury to enter into contracts for the erection of a $1,000,000 building, on ground to be donated for the purpose, for such a central experiment station. Senator Smoot has adopted the same language used in the act providing for the Pittsburgh station. The King bill proposes that $500,000 be made available for the establishment of such a station.

An important program of experimentation in the beneficiation of certain nonmetallic minerals is being contemplated by the Bureau of Mines. Because of dwindling resources of the high-grade fluorspar, the beneficiation of the low-grade material will be included in the program. This particular problem will be in compliance with requests from various steel makers.

Jack Waite Property Adds Equipment to Mill Zinc Ores

The Jack Waite Mining Company, operating in what is known locally as the North Side in the Coeur d'Alene district, Idaho, is adding another Hardinge ball mill to its milling plant, which will increase its capacity to 200 tons a day. Additional cells will also be installed in the flotation section to provide differential treatment. In certain parts of the Jack Waite mine there is much zinc associated with the lead-silver ore. Up to this time, production has been confined to ore that is practically free from zinc, but with the addition to the mill the purpose is to mine all ore, which will result in a substantial zinc product as well as lead. In the mine, sinking has started from the main operating tunnel, and a new hoist is now being installed. The shaft will follow the ore, and at a depth of 200 ft. drifts will be extended east and west. The Jack Waite has been operated irregularly for many years, but it was not until within the past year and a half that it was developed to a stage that gave it an assured future as an important producer. This condition was brought about under the management of N. L. Savage, a practical miner who has for several years been highly successful in leasing operations.

Golden Center Mines Leases Claims in Cove District

Golden Center Mines, Inc., has taken a twenty-year lease and option to purchase on the Big Blue, Sumner, Content, Nellie Dent, and other claims, comprising some 400 acres, which properties are in the Cove mining district, near Kernville, Kern County, Calif. Control of these properties has been in the hands of C. S. Long, R. L. Long, and Percy V. Long for the last twenty years or more. Operations will be conducted under the direction of Messrs. Lindberg and Browning, consulting engineers of Los Angeles.

The first work that will be done will be to continue the drain tunnel on the Big Blue property into the hanging wall to establish workings from which to start diamond drilling to explore the vein below present workings. Ample funds are available to develop the holdings. Actual work started Oct. 1, 1927.

To Build Dickens Mill in the Spring

C. H. Whittum, of Rawlins, Wyo., president of the Dickens Consolidated Mines Company, following a recent meeting of the directors in Wallace, Idaho, announced definitely that a mill would be constructed in the spring, and that all plans would be completed during the winter so that work could start at the earliest possible date. The mill will be designed by W. L. Zeigler, superintendent of the Hecla mill. Development is proceeding during the winter, work being confined to the 400 and 500 levels, where much ore is being developed and which, with the ore proved in the upper workings, gives assurance of an abundance of tonnage for the mill, which will probably have a capacity of 200 tons a day.

Mexico City Letter

By W. L. Vail
Special Correspondent

General Strike Threatened by Labor Organizations at Amparo, Jalisco

Mexico City, Dec. 15—The principal news of the week is the threatened strike at Amparo, Jalisco, where, according to reports, the management intends a reduction of workmen and a wage cut on the first of the year. The labor organizations have threatened to retaliate with a general strike throughout that region and adjacent regions. This would involve the Cinco Minas as well as other properties in the district. Another item of interest is the proposed labor law, which is pending in the senate. Mine owners have taken a keen interest in the measure and have hoped to be able to modify some of the original features which seem to them to be impractical. As Congress adjourns at the end of the month, it is quite probable that the president will be given extraordinary powers in matters of legislation and finance. Unless this is done much necessary legislation will suffer, especially matters now being discussed with Ambassador Morrow. Many of these latter subjects, however, will probably be held over until after the close of the Pan-American Conference at Havana in January, as the Ambassador will attend the conference and participate in its sessions. Relations between the two countries, however, are exceptionally friendly at this time and optimists see a permanent settlement of many irritating problems. The presence in the capital of Will Rogers and Colonel Charles A. Lindbergh, as good-will messengers, has also had an excellent effect, the Mexican officials and public meeting these overtures of friendship fully halfway.

Reports from Durango state that Santa Maria del Oro Mines is doing considerable diamond drilling and other exploration work on the company's properties in that state. The Santa Maria was formerly the Lustre Mining Company, of Pittsburgh, Pa., but was recently reorganized. Formerly the ores were smelted at the property, but the high cost of transportation for fuel and revolutionary activities caused a shutdown about ten years ago. George A. Schroter, of New York City, is consulting engineer for the company. At Inde the Cia. Minera y Beneficiadora is working the Terrible, Guadalupe, and Matracal mines as a group. French capital is financing these operations.

Active operations prevail in the Parral camp, Chihuahua. San Francisco Mines of Mexico, Ltd., is milling 800 tons of lead and zinc ores a day. E. A. Strout is general manager of the property and S. R. Brown, assistant manager. The Parral unit of the American Smelting & Refining Company is milling 750 tons of ore daily, and the Santa Barbara unit of the same company is milling 1,600 tons of lead and zinc ores a day. At the latter property, a reclamation plant to handle 400 tons of zinc tailings a day is being erected. The report of the purchase of the Iguana mine, Parral, from Mike McDonald, by the American Smelting & Refining Company, is confirmed. This is the property which was under option for some months to the Real del Monte Company, of Pachuca. The Pallmilla unit of the American Smelting & Refining Company is still closed, and the San Patricio mine is shut down in the same district. Owners of the Caiman property are making arrangements with the Southwestern Engineering Company, of Los Angeles, for the erection of a mill.

The following ore exports through the port of Tampico during the first ten months of the year have been announced:

	Destination	October, 1927, Kilos	January to Sept., 1927, Kilos
Zinc concentrates	Antwerp	17,451,901	138,616,507
Zinc concentrates	Dunkirk	2,612,910	3,504,780
Calcinated zinc	Antwerp	6,608,729	10,455,579
Calcinated zinc	Dunkirk	1,062,850	17,990,178
Zinc ingots	Liverpool	.....	4,015,067
Lead bars	New York	11,861,630	85,807,811
Lead bars	Hamburg	7,207,004	24,798,593
Lead bars	Rotterdam	2,083,152	11,481,296
Lead bars	Liverpool	508,060	15,146,046
Lead bars	London	.....	13,422,395
Lead bars	Havre	711,190	4,323,310
Lead bars	Marseilles	508,075	711,275
Lead bars	Antwerp	.....	507,995
Lead bars	Murmansk	.....	751,860
Copper bars	New York	1,725,335	8,878,853
Antimony	New York	109,098	63,328
Antimony	Hamburg	55,100	.....
Antimony	New Castle	.....	666,115
Arsenic	New York	24,332	3,752,725
Arsenic	Genoa	48,895	.....
Arsenic	Hamburg	189,799	65,393
Arsenic	Rotterdam	.....	451,045
Arsenic	Liverpool	.....	341,802
Total kilos		52,768,060	345,251,980

For the week ending Nov. 26, 148 cars of lead bars were shipped through Tampico, 128 cars of zinc ores, 9 carloads of copper matte, and one car of arsenic. Most of the shipments were for European ports.

A. H. Child has resigned as managing director of the Gardner-Denver company, and has been succeeded by L. W. Rodolf, formerly assistant manager of the El Paso office. O. C. Waggner is in charge of the City of Mexico offices.

The Descubriadora, Chihuahua, has been closed, by consent of the mining department, it being demonstrated that the mine had been run at a loss for some time, owing principally to the low price of metals.

Julian Interests Stop All Work in Arizona

According to reports, work has been entirely stopped at the Monte Cristo mine of the Julian Merger Mines, Inc., at Wickenburg, and the pumps have been pulled. With the shutting down of the Monte Cristo and the recent abandonment of the Ballas property at Ajo, the Julian interests have now stopped all Arizona work.

Johannesburg Letter

By John Watson
Special Correspondent

October Output of Gold on Witwatersrand Announced

Johannesburg, Nov. 19—The output of gold for the month of October was declared by the Transvaal Chamber of Mines on Nov. 10 as 855,743 oz., having a value of £3,634,966. Compared with the record for the previous month, these figures show an increase of 13,625 oz., equal in value to £57,876. The record month was last August, when the output reached 863,345 oz. Native labor returns show that a total of 188,025 "boys" were employed on the Witwatersrand gold mines on Oct. 31, an increase of 1,612 over the number working in the previous month.

H. Heckler, of Potchefstroom, has recently been prospecting in Namaqualand and Southwest Africa and traced the diamondiferous gravel from Port Nolloth and the month of the Orange River, over the route taken by Dr. Merensky, up into the Kalahari. He claims that the deposits he found were extraordinarily rich—far richer than all the present diggings. Mr. Heckler has had twenty years' experience in prospecting and "digging," and scouts the idea that the Kalahari desert is waterless, as he had no difficulty in finding water at 3 to 4 ft. below surface. He proposes forming a small syndicate and hopes to return on a six months' prospecting expedition.

The Consolidated Goldfields of South Africa, Ltd., announces the declaration of a dividend of 15 per cent, on the ordinary shares, for the year ended June 30. This is the company's highest dividend payment in fifteen years; the dividend for the previous year was 12½ per cent.

A Norwegian scientific expedition is en route to Cape Town, whence it will sail for Enderby Land, a 3,000-mile stretch of the Antarctic continent. Investigation promises a rich harvest in geology, meteorology, and, possibly, botany. Little has been seen of Enderby Land since its discovery by a whaler.

Onverwacht Platinum's reduction plant treated 2,290 tons of ore during October, yielding 385 oz. of refined platinum and allied metals, equivalent to 3.362 dwt. per ton milled.

Lydenburg Platinum Areas reports that during October, on its Maandagshoek section, 2,844 tons of ore was milled, yielding 602 oz. of platinum group metals.

The Union parliament has adjourned until January 25, after passing the precious stones bill, in a joint session of the legislative assembly and the senate.

Repairs to Sub Nigel No. 1 shaft rock hoist have been completed and it started work on Nov. 8.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Noranda Mines May Move New York Offices to Toronto

TORONTO, DEC. 17—It is expected that the blowing in of the Noranda smelter will not be the only important development to take place shortly in that company. With the increased Canadian stock ownership it is felt that there should be a proportionate representation on the board of directors. As control of the stock is now held in Canada by a substantial margin, there would be no difficulty in effecting such a change. It is also believed that the New York offices will be moved to Toronto. At present J. Y. Murdoch and N. A. Timmins are the only Canadian directors. Developments at the mine continue favorable, and the vertical extensions of some of the main orebodies should be cut on the 500 level in January.

A new orebody has been cut by a diamond-drill hole on the Amulet property. This ore lies south of the fault which is south of No. 4 shaft; the drill hole cut 90 ft. of high-grade ore. Indications point to an orebody in which the larger proportion of values are in copper, but carrying zinc on the margins. A survey for a railway branch to the mine has been completed and an early start is expected on construction work.

A RUMOR is current that the Canadian Pacific Railway will also build a road into the Rouyn district. A line might be run from Angliers, a distance of 50 miles, or from Mount Laurier, a distance of 200 miles. The latter would give a shorter route to Montreal and would open up good mining and pulpwood country. It is believed that people closely connected with the Canadian Pacific Railway have acquired a substantial interest in International Nickel, which some years ago was the largest individual shipper on the company's system. The Consolidated Smelting Company, which is controlled by the Canadian Pacific Railway, was anxious to build a smelter in the Rouyn field, and it is well known that the railway would like to get a share of the large amount of freight which is likely to develop in Rouyn. Outgoing freight will consist not only of copper, but, for some time at least, all zinc concentrates produced will have to be shipped out of the camp.

During November Dome Mines treated 45,160 tons and recovered $375,424, or an average of $8.25 a ton. This is the largest output of any month during the present year and is an increase of approximately $50,000 over the record for the preceding months. Reports have been current lately regarding new discoveries on the Dome property, and statements have been freely made that these discoveries have assured at least a year's supply of ore. The president of the company states that these reports are greatly exaggerated. Some new ore has been found, particularly on the 9, 10, and 11 levels, but tonnage and grade are substantially less than the reports would indicate.

Gold production of Ontario mines for November again established a new high record, production being $3,132,055. The output from Porcupine was the highest of any month of the present year, and Kirkland Lake exceeded its previous high record by a substantial margin. Total tonnage treated by all the gold mines was 368,031 tons, the recovery being $3,132,055, an average of $8.52. The Porcupine mines alone treated 292,493 tons and recovered $2,170,000, an average of $7.42 a ton. This is a smaller tonnage but a higher average than for some months. Kirkland Lake mines treated 75,538 tons and recovered $961,500, an average of $12.70. This is a decrease of 3,000 tons but an increase of $70,000 as compared with the previous month.

Aside from operations on the Flin Flon and the Sherritt-Gordon, there is a good deal of activity throughout the northern Manitoba district as a whole. It is understood that $400,000 has been raised to develop the Baker-Patton zinc-copper property. The proposed work will include sinking two shafts and doing considerable diamond drilling. A large amount of work will be done on the Smith-McDonald property near Cold Lake; an oil-burning plant is to be installed, and a large amount of freight and supplies is now being hauled in from Mileage 55.

The Sudbury Basin Mines, Ltd., recently took an option on the Cheney copper property, about 25 miles north of Thessalon on the line between Sudbury and Sault Ste. Marie. This property was under option to the Timmins interests several years ago, and several cars of high-grade copper ore were shipped to New Jersey. A plant is being taken in and the property will be extensively developed. In addition to the Cheney, the Sudbury Basin holds a variety of interests. It has a large acreage in the Sudbury section adjoining the claims held by the Treadwell-Yukon Company. It owns properties in the Red Lake and Woman Lake sections; has stock holdings in the Bathurst Mines, Ltd.; a controlling interest in the Jarvis Island barite property; an interest in a barite property at Tianoga, Ont.; and has, in addition, 171,000 shares of the Sherritt-Gordon property.

Pickands, Mather Mine Named for Superintendent

Pickands, Mather & Co. have ordered the name of the Wilkinson mine, on the Menominee range, changed to the Lawrence, thus honoring C. E. Lawrence, who for many years has been in charge as superintendent of the mines of the company on the west end of the Menominee.

London Letter

BY W. A. DOMAN
Special Correspondent

Russo-Asiatic Consolidated Issues Report Showing Improved Prospects

LONDON, DEC. 13 — In the Russo-Asiatic Consolidated report, issued this week, there is a note of cheerfulness almost amounting to optimism. More hope is expressed—and with seemingly better prospect of fulfilment—than for several years past. This hope has a triangular aspect: It refers to relations with the Soviet authorities, the prospects of Mount Isa in Queensland, and the position of the mines at Villemagne, in France. The recent meeting between Sir Austen Chamberlain and Litvinoff is regarded as a change of sentiment on the part of the Russians. They sought the interview, and Litvinoff was recognized. Statements referring to the Moscow conference and indorsing the latter's attitude have appeared in Russian newspapers. The old "Red" leaders are being thrown over, and something very like common sense was expressed. The present moderate leaders of the party have on more than one occasion stated that Rakovsky spoiled the relations with this country which Krassin was cultivating. Instead of preaching peace, he preached war, and financed strikes in Great Britain. This is acknowledged to have been a mistake, as is also the policy of the extremists in China.

RESPONSIBLE men stated at the conference that Russia had not repudiated her debts, but had said that the total was too great to be paid all at once, and that there were three questions to be decided: how much is to be paid; to whom it is to be paid; and what Russia will get in return. This looks like a change of front.

Bwana M'Kubwa has been to the fore again, and one thought expressed concerning the property was to the effect that it was not yet a success because the technical management had too much of the gold-mining practice about it. The meeting of shareholders yesterday was not altogether a smooth affair, but it ended without some vital questions being answered, this being due mainly to interruptions which turned the majority of shareholders present in favor of the directors.

The diamond share market has had a bad slump as the result of De Beers passing the interim dividend on the deferred shares. It is said there are diamonds which cannot be sold, and that the Consolidated Mines Selection, which is interested, will halve its next dividend in consequence. Reports are current that the Anglo-American Corporation will form another diamond company—in Namaqualand this time, according to reports.

Societies, Addresses, Reports

Southern California Holds Mineral Conference

ON DEC. 15, a regional mining conference of the southern counties of California was held at Los Angeles. These conferences are sponsored by the California Development Association and local chambers of commerce. Rush T. Sill presided. W. R. Tucker, of the California State Mining Bureau, presented a statistical summary of California mineral production. John E. Hodge, chairman of the Southern California section of the American Institute of Mining and Metallurgical Engineers, spoke about the work of the Institute in relation to the mining industries. R. R. O'Brien, representing the Santa Fe railroad, stated that in 1928 it is expected that the new discoveries of borax near Muroc would produce 1,000 tons per month. Filtering clays from Ash Meadows are being actively mined and are displacing fuller's earth. At Oceanside, a sand suitable for glass making is being developed to compete with Belgian sand. An increased tonnage of limestone and gypsum is being mined as well as manganese ores. Black sand, from which ilmenite is obtained, is produced at Redondo, the ilmenite being utilized by paint manufacturers. The need for careful sorting of feldspar and silica was stressed by Mr. O'Brien, who stated that inquiries for non-metallic minerals are increasing and that information about mineral resources is being compiled.

Other railroad representatives discussed mineral development and resources in areas contiguous to their lines. The important point established was the fact that the three great railroads, Southern Pacific, Santa Fe, and Union Pacific, through their geological departments, are investigating and making available for industries information about non-metallic mineral deposits.

Representatives of local chambers of commerce reported upon mining activities in their localities, which in the aggregate indicated the gradual growth in importance of non-metallics in the Southwest, which is likewise rapidly developing manufacturing industries.

F. R. Wickes stated that there was a large potential market for the various grades of talc. George H. Parsons described the opening up of a pumice deposit near Bishop and the utilization of dry separators for cleaning the mineral. The use of pumice in plaster for sound-deadening and in making light-weight concrete was mentioned. G. Ray Boggs stated that some five or six millions of tons of magnesium silicate clays had been exposed in the Death Valley area and steady shipments were being made of the material to oil refineries and to the vegetable-oil trade, wherein it is used for filtering and decolorizing.

Resolutions were presented and passed by the conference as follows: Asking the American Mining Congress to use its efforts to remove any federal taxes to which gold producers might be subjected; calling for the simplification of land patent procedure; asking for the safeguarding of mineral lands within the confines of federal withdrawals; calling for additional appropriations for the Bureau of Mines and the U. S. Geological Survey; asking chambers of commerce to promote the use of properly prepared sand and gravel materials and to warn investors of the present overcrowded conditions of the sand and gravel industry, wherein competition is such as to make the industry unprofitable; asking for additional field assistance in the southern California division of the California State Mining Bureau.

J. J. Jakosky to Lecture at the University of Utah

DURING February, a series of lectures on the leading methods of geophysical prospecting will be delivered by J. J. Jakosky, consulting engineer of the Radiore Company, at the University of Utah under the auspices of the Intermountain Station of the U. S. Bureau of Mines. Mr. Jakosky visited the university during the latter part of November at the invitation of Dr. Dorsey A. Lyon, supervising engineer of the station and director of the university's department of mining and metallurgical research. On the occasion of his visit, Mr. Jakosky outlined for the staff of the station and department the salient features of the Radiore process. Dr. Lyon, in explaining the purpose of the speaker's visit, said:

"The university and the Bureau are highly desirous of making this department the outstanding institution for mining and metallurgical research in the country, and, to this end, we plan to bring here the leaders in each field, to explain leading developments as they appear.

"Mr. Jakosky is on his way at the present time to conduct research work with the Radiore process in Canada, and upon his return, probably the first week in February, he will deliver a series of four lectures on leading methods of prospecting. These lectures will be open to the public, and a particular invitation is extended to all members of the mining industry. They will cover such systems as: The torsion balance, self-potential system, and the magnetometer system. Prior to these lectures, the U. S. Bureau of Mines will issue a technical paper covering the whole range of geophysical prospecting, and these will be used as manuals during the program. Mr. Jakosky's lectures will use specially constructed apparatus slides and curves to demonstrate his points."

Metric Standards Urged at Pacific Conference

CALLING upon Congress to adopt the decimal metric weights and measures in the United States, the Pan-Pacific Standardization Conference met recently in San Francisco during the Pacific Trade and Travel Exposition. A series of round-table discussions were held, at which reports were presented from Japan, Australia, Mexico and South America, indicating a worldwide trend to the metric units.

"It is manifest that the future trade of the Pacific is to be largely upon the metric basis," declared Calvert E. Hydes at the final session, "and it is urgent that the United States shall unify its commerce on these unvarying standards likewise. Already, the Philippines, Japan, Siberia, Indo-China, the Dutch Indies, Siam, French Oceania, Mexico, the Central American republics, Colombia, Ecuador, Bolivia, Peru and Chile are among the Pacific countries on the metric basis. The Orient has definitely decided upon metric units, and has rejected the so-called English units. China, for instance, is making rapid progress in adoption of the metric standards."

Endorsement was given to the Britten-Ladd Metric Standards Bill, introduced during the sessions of the present Congress, providing for gradual establishment of metric measures.

Advisory Committee to Minerals Division Formed

The Department of Commerce announces the formation of an Advisory Committee to the Minerals Division of the Bureau of Foreign and Domestic Commerce. The following members comprise the committee: Joseph Clendenin, *chairman*, vice-president, Guggenheim Brothers; Hamilton Brush, vice-president, American Smelting & Refining Company; Raymond B. Ladoo, U. S. Gypsum Company; W. C. Bennett, vice-president, Nichols Copper Company; John Hughes, assistant to president, U. S. Steel Corporation; A. W. Allen, editor, *Engineering and Mining Journal;* J. R. Van Brunt, vice-president, The Chase Brass & Copper Company; E. A. McKelvy, vice-president, General Refractories Company; Alfred Dodd, vice-president, The American Zinc, Lead & Smelting Company; M. W. Tuthill, *secretary*, president, Tuthill & Company, Inc.

Utah Section Discusses Geophysical Prospecting

Geophysical prospecting was the chief subject of discussion at the meeting of the Utah section of the A.I.M.E. held on Dec. 8 at Salt Lake City. Sherwin F. Kelly, of Schlumberger Electrical Prospecting Methods, and Carl W. Chilson, of the Argus Research Corporation, were present and addressed the meeting.

Recent Technical Publications

GEOLOGY AND NATURAL RESOURCES OF COLORADO. By Russell D. George. University of Colorado, Boulder; pp. 228. Price $2.00.

The eleven chapters of this book have to do with the rocks, minerals, topography, and drainage of the state; the geologic eras; the various metals and the industries engaged in producing them; the fuels, structural materials, water and other resources of the state. Chapter 6 discusses the future of metal mining in Colorado. The author thinks that with such a vast area and, therefore, possible mineral ground which is but little known, much reason exists to predict a long period of prosperous mining.

GOODMAN MINING HANDBOOK. Goodman Manufacturing Company, Chicago. Price $2.50.

The fifth edition (for 1927) of this well known handbook, although issued by a manufacturer of mining machinery, contains so many data of value to the engineer that it should not be mistaken for a catalog. Many of the data relate to coal mining practice, but the metal mining engineer will also find much to interest him. Pages 432.

METALLURGY—The *Mining Congress Journal* for December contains an article on "The Inspiration Leaching Plant" by H. W. Aldrich; also one entitled "Re-treatment of Concentrates at Miami Copper Company," by H. D. Hunt; and an article entitled "Reverberatory Practice at Magma Smelter," by J. H. Rose.

ORE TESTING—*Mining and Metallurgy* for December contains a short article entitled "Testing Ores for the Small Operator," by L. O. Howard. Mr. Howard is of the opinion that the small operator should be given a fuller interpretation of the operating details of the methods proposed for treating this ore than he usually receives.

DIAMONDS—The Oct. 22 issue of the *South African Mining and Engineering Journal* contains a description of a special concentrating jig that has been developed to treat the coastal diamonds, which are not amenable to the usual grease separation. This jig is of Schiechel type and is known in the diamond district as the "schickel pot."

CLEAN MINING—"The Practical Aspect of Cleaner Mining" is the title of a paper by J. V. Muller, recently read before the Chemical, Metallurgical and Mining Society of South Africa. The question of narrow stoping widths has been well to the fore lately in connection with Rand mining practice, the author says at the outset, the object being naturally to produce a better grade of ore for the mill, and consequently a higher profit to the mines. He demonstrates that this can be done by cleaner mining and by selective mining. The article is illustrated.

GEOLOGY—*Economic Geology* for December contains the following four articles: "Oxidation Subsidence at Bisbee, Arizona," by Edward Wisser; "Oil and Gas Possibilities of Virginia," by Albert W. Giles; "A Lead Ore Consisting of Native Lead, Leadhillite and Lithargite," by Earl V. Shannon; and "Microchemical Tests in the Identification of Opaque Minerals," by H. E. McKinstry.

CARNOTITE—Long search has resulted in the discovery of crystalline carnotite in Cane Springs Pass, Utah. The mineral is described in a six-page bulletin (No. 2708, from the *Proceedings* of the National Museum). The authors are Frank L. Hess and William F. Foshag.

ELECTROLYTIC ZINC—"Formation and Decomposition of Zinc Ferrite," by Carl E. Swartz and Francis C. Krauskopf, is the title of a paper issued by the A.I.M.E. as Technical Publication No. 40. It contains 19 pages.

PLACERS, ARIZONA—A second edition, revised, of "Arizona Gold Placers," by Eldred T. Wilson, has been issued by the University of Arizona, as Bulletin 124.

MINT REPORT—The Annual Report, for 1927, of the Director of the Mint, has made its appearance. It includes a report on the production of the precious metals during 1926.

ARIZONA GEOLOGY—Bulletin 123, issued by the University of Arizona, Tucson, is entitled "Geology and Ore Deposits of the Courtland-Gleeson Region," by Eldred T. Wilson. This region, which is known also as the Turquoise district, is in the south central part of Cochise County, about 15 miles east of Tombstone. From 1907 to 1924, inclusive, it has produced 45,750,115 lb. of copper and 2,136,304 lb. of lead, with an unknown amount of gold and silver. It got its name because of the existence of deposits of turquoise, long known to the Indians.

CANADA—The Summary Report of the Dominion Geological Survey for 1926, Part C, has been published. It presents the results of investigations conducted during 1926 by field parties in Ontario, Quebec, New Brunswick and Nova Scotia. The question of origin of the copper ores of Rouyn is discussed. Brief notes are given on the gold fields of Nova Scotia, the lead-zinc deposits of Leadvale, also in Nova Scotia, and the copper deposits of Goshen and Annidale, in New Brunswick.

Part A, of the same report, contains an article on "Placer Gold and Lead-Zinc Deposits, Dogtooth Range, Kootenay District, British Columbia"; also notes on various other areas in British Columbia, and in the Yukon.

WOOD PRESERVATION—The same bulletin of the Canadian Institute also contains a 20-page article on "Mine Timber; Its Conservation, Preparation, Storage, and Treatment," by W. D. Haley.

ARSENIC—"Arsenic-bearing Deposits in Canada" is the title of Bulletin No. 4 of the Dominion Geological Survey's Economic Geology Series. The author is M. E. Hurst. The several chapters cover the statistics, economics, mineralogy, and general geology of arsenic occurrences, with a general description of each. A chapter is devoted to a brief summary of foreign deposits. The bulletin contains 181 pages.

EMPIRE CONGRESS—The December *Bulletin* of the Canadian Institute of Mining and Metallurgy includes the final number of *The Congress News*.

NEW PATENTS

PULVERIZER. No. 1,651,372. Dec. 6, 1927. John Charles Carline, Hull, England.

A pulverizer with a horizontal beating chamber containing a beater with radial arms, used in conjunction with an air separating system and chamber.

KILN. No. 1,651,380. Dec. 6, 1927. Philip D'Huc Dressler, Cleveland, assignor to American Dressler Tunnel Kilns.

An open fired tunnel kiln having fire boxes distributed along the length of the firing zone on each side of the kiln, the kiln having double side walls for a definite purpose.

BLASTING. No. 1,651,479. Dec. 6, 1927. Thomas Spears, Bisbee, Ariz.

A device for spitting blasting fuses.

DESULPHURIZING. No. 1,651,492. Dec. 6, 1927. Richard Walter, Dusseldorf, Germany.

A process of desulphurizing molten metal and briquets used therefor.

LEACHING. No. 1,651,680. Dec. 6, 1927. Henry Y. Eagle, Brooklyn, assignor of one-half to Archer E. Wheeler, New York.

A leaching apparatus comprising a tank having at a point above the normal level of the pulp a receiver arranged to discharge part of its contents from the tank and to return a part; also, a means for lifting the agitated pulp into the receiver.

DRILL STEEL. No. 1,651,930. Dec. 6, 1927. Gustave M. Nell, Denver, assignor to the Denver Rock Drill Manufacturing Company.

A means for opening the bores of steels for rock-drilling purposes.

FLOTATION. No. 1,652,060. Dec. 6, 1927. Carroll C. Smith, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.

A process of concentrating ores and minerals by flotation, by subjecting the pulp to a flotation operation in the presence of a thiazole compound and a soluble sulphide.

FLOTATION. No. 1,652,099. Dec. 6, 1927. William A. Douglass, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.

A process of concentrating ores and minerals by flotation, by subjecting the pulp to a froth flotation operation in the presence of an alkyl xanthogen formate

Personal Notes

FREDERICK G. CLAPP is engaged on geological investigations in Persia.

CARL F. WITHAM, of Chisana, Alaska, is in New York on a business trip.

DR. SAMUEL EVANS, chairman of the Crown Mines, is returning to the Union of South Africa.

S. A. LEWISOHN, vice-president of the Miami Copper Company, has made his annual visit to the mine at Miami, Ariz.

SYDNEY H. BALL, of Rogers, Mayer & Ball, spent about ten days in the early part of December examining mining property in Montana.

OSCAR H. HERSHEY, consulting geologist of San Francisco, was recently at Tybo, Nev., on geological work for the Treadwell-Yukon company.

H. J. C. MACDONALD, mining engineer of Denver, is in New York for a brief business visit. He is staying at the Hotel Pennsylvania.

FREDERICK GUCK, former editor of the *Mining Gazette*, of Houghton, Mich., has been elected a vice-president of the Union Trust Company, of Detroit.

JOHN M. NICOL, mining engineer of San Francisco, left late in December for Nicaragua, where he will examine mining properties.

ALDERSON & MCKAY, mining engineers, have been appointed consulting engineers for the Rhyolite Rouyn Mines, operating in the Rouyn area of Quebec.

D. R. THOMAS has been appointed chief advisory engineer and F. L. JAMES field engineer for the Leval Quebec, operating in the Rouyn area.

CHARLES A. MITKE has returned to Phoenix, Ariz., after a professional visit to the iron mines of the Colorado Fuel & Iron Company in Wyoming.

DR. GEORGE W. CRAVEN, president of the Montana State School of Mines, has resigned, his resignation to become effective at the close of the school year in June, 1928.

P. V. ROUNDY left Washington recently to attend a sale of Osage leases at Pawhuska, Okla., at the request of the Office of Indian Affairs.

DOUGLAS CHRISTOPHERSON, president, and WILLIAM GEMMILL, general manager, of the Transvaal Chamber of Mines, left Johannesburg on Nov. 6, on a brief visit to Cape Town.

S. M. SOUPCOFF, field engineer for the American Smelting & Refining Company, with headquarters at Salt Lake City, is in Nevada on professional work.

O. E. SCHIFFNER, superintendent of the Rescue-Eula mine, in Tonopah, Nev., has returned to Tonopah from an examination trip into the Grass Valley section, in California.

TUTHILL & COMPANY, New York City, have been appointed general agents in North America for the Mansfeld A. G. f. Bergbau u. Hüttenbetrieb, Eiseleben u. Hettstedt, Germany.

WILLIAM H. HAX, president of the Basin-Montana Tunnel Company, recently spent some time in Butte and Seattle in the interest of the company. He returned to New York on Dec. 31.

WILLIAM BURNS, at one time on the engineering staff of the Phelps Dodge Corporation at Bisbee, has been appointed manager of the N'Changa Copper Mines, Ltd., in Northern Rhodesia.

CLARENCE R. KING, formerly metallurgist for California Rand Silver, Inc., at Randsburg, Calif., has taken a position with the United Verde Copper Company, and will be at Clarkdale, Ariz.

DOUGLAS A. MUTCH, mining engineer, has completed an examination of the Amulet mine, in the Rouyn area of Quebec, which he stated confirmed his former estimates of ore reserves.

MAX J. WELCH, some years ago an occasional contributor to this publication, is now located in the Metropolitan Theatre Building, Los Angeles. He has just completed a full set of plans for a 300-ton tailings plant to be built near Guanajuato, Mexico.

O. M. KUCKS, general manager of the Andes Copper Company, with headquarters at Portrerillos, Chile, and E. G. LITTLER, general purchasing agent for the Anaconda Copper Mining Company, are visiting Arizona copper districts.

E. F. WILSON left New York recently for Fresno, Colombia, South America, where he will make an examination of a large placer area. This work will be done under the direction of the Ludlum Engineering Corporation for New England clients.

JAMES E. PEMBERTHY, formerly with the Phelps Dodge Corporation at Nacozari, Sonora, Mexico, and later manager of the Teziutlan Copper Company of the Mexican Corporation, is leaving for the Belgian Congo, where he has accepted a position with the Katanga company.

LYMAN F. BARBER, a Los Angeles mining man, reported kidnaped by Mexican bandits near Zacualpam and held for ransom even after 1,000 pesos had been paid for his release, is reported safe, the additional information being that the Mexican officials are taking all possible measures to assure his release.

MAJOR GEORGE C. RILEY and GEORGE C. MACKENZIE, of the Canadian Mining Institute, have been appointed chairman and general secretary, respectively, of the main committee for the next meeting of the Empire Mining Congress to be held in South Africa. They sailed for England recently to arrange details for the African meeting.

GORDON R. CAMPBELL, of Calumet, Mich., president of the Calumet & Arizona Mining Company, accompanied by THOMAS HOATSON and THOMAS COLE, members of the board of directors, and Auditor H. P. PAULL, recently inspected the company's properties at Bisbee and at Hiltano, near Tucson, and the Verde Central mine at Jerome.

J. L. PHILLIPS, who has operated extensively in South America and Mexico, is making a tour around the world. He sailed from San Francisco on Dec. 28, to visit the principal mining districts in Australia and South Africa, where he will represent the Braun Corporation, of Los Angeles, in the interests of the Herman mill.

F. I. CAIRNS has resigned as superintendent of the Michigan smelter at Houghton, Mich., effective Dec. 31. He has been in charge of operations at the plant since its construction 24 years ago. He will go south to join his son, who is recovering from a serious illness. GEORGE A. SCHUBERT, professor of civil engineering in the Michigan College of Mining and Technology at Houghton, will succeed him.

HARRY A. CLARK, general manager of the Calumet & Arizona Mining Company, was chosen governor of the Arizona chapter of the American Mining Congress at the organization's annual election of officers which was held recently in Phoenix. Mr. Clark succeeds F. W. MACLENNAN, general manager of the Miami Copper Company, who has been governor during 1927. Other new officers elected for the ensuing year are C. A. SMITH, of Hayden, manager of the Nevada Consolidated Copper Company, first vice-governor; T. H. O'BRIEN, general manager of the Inspiration Copper Company, second vice-governor, and W. B. GOHRING, of Phoenix, secretary.

E. D. GARDNER, superintendent of the Southwest Experiment Station of the Bureau of Mines in Tucson, in conjunction with D. J. PARKER, who is in charge of safety work in the West for the Bureau, has just completed a survey of safety organizations in the metal mines of Arizona. Results of the survey will be published in a bulletin. According to Mr. Gardner, the number of accidents in 1926 was only half the number for 1925 and the record for 1927 shows almost the same improvement over 1926. The survey indicates that the mines having the best records of accident prevention are those in which the authorities have become satisfied that most accidents are preventable and have taken steps to reduce them to a minimum. The aim of the Bureau in this work is to persuade mining companies that safety can be obtained and that it should be a major consideration.

OBITUARY

JOSEPH S. MITCHELL, head of the diamond-drill department of the Sullivan Machinery Company, died on Dec. 22.

DAVID WILLIAM BRUNTON died in Rochester, Minn., on Dec. 20. An appreciation of Mr. Brunton's life and work will appear in an early issue of *Engineering and Mining Journal*.

Market and Financial News

Demand for High-Grade Zinc Features European Market

TOWARD the end of November, sentiment in the zinc market appeared to be hardening, says the International Metal Service, of London, in its monthly report to the American Zinc Institute, dated Dec. 1. "Just why is a little uncertain, and probably it was more a case of the more optimistic feeling in other sections of the market—especially as regards lead—being reflected in the zinc section than any more solid ground. The situation on the Continent seems sound enough. Russia and the Central European states have again taken some good tonnages off the German market.

"During the month the Giesche concern announced that, owing to the continued low price of zinc, it was closing its Wilhelminehutte works, which will apparently mean a temporary curtailment of about 450 metric tons monthly. This is the only instance of curtailment for this reason, though of course there may be a further cut through the stoppage of certain plants for the purpose of reorganization.

"The strongest feature of the European markets has been the demand for High-Grade both in Britain and on the Continent. With America not selling and arrivals of Australian metal not particularly heavy, there has been something near a scarcity of actual spot metal, and the premium has stiffened to £3 a long ton. However, toward the end of the month American brands were offered more freely, and the position may soon be regulated.

"The galvanizing trade has been distinctly disappointing and must remain so until the situation in India improves—just another case of over-optimism earlier in the year, as to the prospects, which led to heavy speculative buying by merchant houses which are consequently now cluttered up with excessive stocks which they have been unable to move. Since the turn of the month there have been signs that the position is getting better, and there has been a moderate amount of buying for this important market for January and later delivery. On the Continent, also, galvanizers are complaining of slack trade.

"In the opening days of December there was a slight jump in the quotation following the news of the Australian shipping strike, but it is significant that this increase was immediately responsible for heavier offerings of metal from the Continent, which rather promotes the thought that there is a certain amount of metal being held for better prices. This, indeed, has been the idea of many people on this side for weeks past, and has been responsible for some of the caution displayed by buyers.

"The British output for November was little different from that of the previous few periods, and was probably not more than 4,600 long tons.

"World stocks of zinc on Dec. 1 are estimated as follows:

	Metric Tons
United States	35,700
Canada	2,500
Australia (including unsold shipments afloat)	2,600
Germany-Poland	6,700
Belgium	4,400
France	1,300
Great Britain	1,500
Scandinavia	200
Far East	600
Elsewhere	1,500
Total	57,000

"Just as we are concluding this a cable has reached London intimating that the supplies of water at Broken Hill are not sufficient to last more than three months. Of course much may happen in the interval, and it will not do to speculate on the chance of any curtailment of output from this cause, but obviously this is a point which will have to be watched fairly closely."

December Dividends Show Increase Over September

DIVIDENDS paid by mining companies operating in North and South America during December exceed by a good margin those for September, the corresponding month for the third quarter. A number of names appear in the list that were absent in September and several increases in the rates of payment are noted.

The only absentee is Keeley Silver Mines, which pays semi-annually and consequently made no disbursement in December. The Caledonia Mining Company, lead-zinc producer in Idaho, distributed 5c. a share, equal to $130,025, as a liquidating dividend following the settlement of taxes and other outstanding indebtedness. The Mohawk Mining Company, a Michigan copper producer, paid $2 per share instead of $1. Mother Lode Coalition, another copper company, continued its regular rate of 25c. semi-annually. Other names in the list of dividend payers that were absent three months ago include New Jersey Zinc, Vanadium Corporation, Silver King Coalition, and Nipissing, Ontario silver producer. Tintic Standard, of Utah, paid 20c. instead of the 40c. disbursed in September. On the other hand, Lucky Tiger-Combination, in addition to the regular payment of 5c. monthly, gave the stockholders a Christmas present at the rate of 7c. per share. A general decline in the rates of yield, indicated in the last column of the accompanying table, is the natural consequence of the climb in quotations for most of the shares.

Mining Dividends and Yields for December, 1927

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
American Metal	U. S. and Mex.	$0.75 Q	$446,127	6.2
American Metal, pfd	U. S. and Mex.	1.75 Q	87,500	6.4
American Smelting & Refining, pfd	U. S. and Mex.	1.75 Q	875,000	4.9
Betty O'Neal Mines, s	Nev.	0.05 K	23,243	....
Bunker Hill & Sullivan, s, l	Idaho	0.75 M	245,250	6.4
Butte & Superior, z, s	Mont.	0.50 Q	145,099	20.0
Calumet & Arizona Mining, c	Ariz.	1.50 Q	964,135	5.5
Calumet & Hecla Consolidated, c	Mich.	0.50 Q	1,002,751	9.1
Caledonia, l, s	Idaho	0.05 L	130,025	....
Eagle-Picher, z, l	Okla.	0.40 Q	400,000	6.7
Federal Mining & Smelting, pfd., s, l, z	Idaho, Okla.	1.75 Q	210,000	7.4
Golden Cycle Mining & Red, g	Colo.	0.04 Q	60,000	5.0
Hecla Mining, l, s	Idaho	0.25 Q	250,000	5.9
Homestake Mining, g	S. D.	0.50 M	125,580	....
Inland Steel	Minn.	0.625 Q	739,249	4.4
International Nickel, n, c	Ont., W. Va.	0.50 Q	836,692	2.7
Mohawk Mining, c	Mich.	2.00 K	230,000	....
Mother Lode Coalition, c	Alaska	0.25 S.A.	625,000	....
National Lead	U. S.	1.25 Q	387,289	3.9
National Lead, pfd "A"	U. S.	1.75 Q	426,433	6.1
Nevada Consolidated Copper	Nev., Ariz., N. M.	0.375 Q	1,215,959	7.1
New Jersey Zinc, z	N. J.	2.00 K	982,000	....
Republic Iron & Steel	U. S.	1.00 Q	300,000	6.7
St. Joseph Lead, l, z	Mo., N. Y.	0.75 XX	1,462,821	7.2
Silver King Coal, l, s	Utah	0.10 Q	121,610	....
Sloss-Sheffield Steel & Iron	Ala.	1.50 Q	150,000	4.9
Tennessee Copper & Cnemical	Tenn.	0.125 Q	99,328	4.9
Texas Gulf Sulphur	Texas	1.00 Q	2,540,000	5.3
Tintic Standard, s, l, c	Utah	0.20 Q	250,583	....
U. S. Steel	U. S.	1.75 Q	12,453,411	4.7
Utah Copper	Utah	1.50 Q	2,436,734	4.4
Vanadium Corp, v	Colo., Peru	1.00 K	378,367	....
Companies in Other Countries				
Amparo Mining Co., s	Mexico	0.01 K	20,000	....
Chile Copper	Cnile	0.625 Q	2,744,528	6.1
Hollinger Consolidated Gold	Ont.	0.10 F	492,000	7.4
Lake Shore, g	Ont.	0.20 X	200,000	....
Lucky Tiger-Combination, g, s	Sonora	0.12 MX	85,840	8
McIntyre-Porcupine, g	Ont.	0.25 Q	199,500	3.9
Nipissing, s	Ont.	0.075	90,000	....
Total			$34,512,054	

s, silver; l, lead; z, zinc; c, copper; g, gold; n, nickel; t, tin; Q, quarterly; L, liquidating dividend; M, monthly; MX, monthly 5c., extra 7c.; BM, bi-monthly; K, irregularly; F, every four weeks; SA semi-annually; X, 10c. regular quarterly and 10c. extra; XX, 50c. regular quarterly and 25c. extra.

The Market Report

Metal Markets Quiet and Steady During Holidays

New York, Dec. 28, 1927—The customary and expected holiday quietness characterizes the metal markets for the week ending today, and no change is expected until after New Year's Day. Prices, however, have been steady, no sellers taking the opportunity to depress the market for any reason. A good spring's business is expected in metal-consuming lines.

Copper Prices Firmer

The large producing interests have continued to quote 14⅛c. for domestic deliveries in the East all week, but have taken only an occasional order, chiefly where a particular brand of copper was desired. A fair amount of business was done in the Middle West last Friday at 14¼c., however. The custom smelters have in general quoted 14c., delivered Connecticut, since last Thursday, when the last of the 13⅞c. copper was absorbed. They seem to be making a firmer stand than they did last week, and are well content to do only a moderate amount of business until after the holidays are over; then another good buying movement is expected, as considerable February copper remains to be bought apparently, and a little January shipment remains to be taken care of also. The export demand during the week has been rather better than was expected; perhaps because foreign buyers have interpreted the firm market for copper shares as evidence of a continued upward movement in prices. The price of the export association continues at 14.50c., c.i.f.

Lead Firm in Dull Market

Though somewhat below average in respect to volume of sales, the lead market has not been dead during the week ending today, a modest tonnage of January metal changing hands. The leading interest in the Middle West quoted 6.325c. all week, but business done at this figure was all but negligible, virtually all the sales by this company being on an "average" price basis. Other sellers did a fair business at 6.30c., and any reasonable amount of metal could have been obtained at that level on any day during the week. In the East the American Smelting & Refining Company maintained its contract price at 6.50c., New York. A feature of the last few days has been the excellent demand from abroad. Prices are a little higher and the contango has narrowed on strength of the spot price rather than weakness in futures. This is interpreted as being an encouraging development, particularly in conjunction with the steady position in the United States. Keen analysts of the market, among consumers as well as buyers, are inclined to think that the next move is more likely to be to slightly higher levels rather than in the reverse direction. This feeling is based more on the generally favorable industrial situation, both at home and abroad, than on any change in the statistical position. The daily rate of world production in November was 4,545 tons, compared with 4,449 tons in October, but this is well under the rate reached several times this year.

Zinc Firmly Held

Some zinc has found a market at 5.625c. in the week ending today, but the price to consumers has generally ruled at 5.65c., St. Louis, for all deliveries, with producers somewhat less inclined to sell forward than prompt. The volume of sales has been very small, with some sellers reporting no business at all. High-grade is neglected, with nominal quotations for spot carloads remaining at 7¾c. delivered.

Daily Prices of Metals

Dec.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
22	13.675	57.75	58.25	6.50	6.30	5.625
23	13.775@13.925	57.875	58.25	6.50	6.30	5.65
24	13.80	57.875	58.25	6.50	6.30	5.65
26	Holiday	.....	.....	....	....	....
27	13.80	57.875	58.125	6.50	6.30	5.65
28	13.775	57.625	57.75	6.50	6.30	5.65
	13.780	57.800	58.125	6.500	6.300	5.645

Average prices for calendar week ending Dec. 24, 1927, are: Copper, 13.708; 99 per cent tin, 57.792; Straits, 58.208; N. Y. lead, 6.500; St. Louis lead, 6.300; zinc, 5.644; and silver, 57.667.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.13c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
22	60 1/4	60 7/16	66 1/2	265 3/4	263 3/4	22	22 1/4	26 3/16	25 7/8
23	60 1/2	60 5/8	66 1/2	266 3/4	262 1/2	22 1/16	22 3/8	26 3/16	25 15/16
26	Holiday	....	...	....	....	....	....	...	....
27	Holiday	....	...	....	....	....	....	....	....
28	60 7/8	61	66 1/2	266	261 1/4	22 5/16	22 1/2	26 3/8	26 1/8

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
22	4.87 3/4	57 5/8	26 7/16	84s10d	26	Holiday	...	....	.....
23	4 87 13/16	57 5/8	26 1/2	84s11d	27	4.87 5/8	57 1/2	... .	.....
24	4 87 3/4	57 5/8	Holiday	.....	28	4.87 5/8	57 5/8	26 7/16	84s11 1/2d
					Avg.		57.600		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-eighths of a cent premium.

Tin Market Quiet

Occasional small orders by consumers and a little trading by dealers constituted the business of a dull week in tin. Prices are a little lower than they were a week ago. Straits suffered more than 99 per cent metal and the spread between the two today is only $\frac{1}{8}$c. Compared with spot Straits, January and February are off about $\frac{1}{8}$c., and March and April about $\frac{1}{4}$c.

Silver Steady

During the last week the silver market has been very steady, but idle on account of the Christmas holidays. The price was supported by moderate buying orders from India and China and the reluctance of sellers to press sales in the local market.

Mexican Dollars (Old Mexican pesos): Dec. 22d, 23d, and 24th, 44$\frac{1}{4}$c.; 26th, holiday; 27th, 44$\frac{1}{8}$c.; 28th, 44$\frac{1}{4}$c.

Foreign Exchanges

Closing cable quotations on the principal foreign exchanges on Tuesday, Dec. 27, were as follows: francs, 3.93$\frac{7}{8}$c.; lire, 5.275c.; and marks, 23.915c. Canadian dollars, $\frac{5}{32}$ per cent discount. Stabilization of the Italian lira on a gold basis, at nineteen to the dollar, was announced on Dec. 22.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 98 or 99 per cent grade, price of leading interest, 24.30c.; outside market, 23.90@24.30c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week 11$\frac{1}{8}$@10$\frac{7}{8}$c. Forward positions through February about $\frac{1}{8}$c. higher.

Cookson's "C" grade, spot, 16$\frac{1}{8}$c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 15$\frac{1}{2}$c.

BISMUTH—Per lb., New York, in ton lots, $1.85@$2.10. London, 8s.

IRIDIUM — Per oz., $175@$185 for 98@99 per cent sponge and powder. Rapid advance from $125. Strong market; shortage of supply.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $49@$50. Small lots bring up to $54.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $72. Dealers and refiners quote the trade for refined metal, per oz., cash, $65@$67. Market moderately active at firmer prices.

QUICKSILVER—Per 76-lb. flask, range for week, $126@$127, depending on quantity. Market very quiet. San Francisco wires $129.50. London, £23; market firm.

RHODIUM—Per oz., $50@$55; London £8@£11$\frac{1}{2}$, nominal.

RUTHENIUM—Per oz., $40. Market strong.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Dec. 3.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn; 34@38c. Caucasian, washed, 53@55 per cent, 38.50@40c. Chemical grades unchanged from quotations in the Dec. 3 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.25@$10.50. Western scheelite, $10.50@$10.75. Market dull with completion of German buying, but asking price steady.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the Dec. 3 issue.

Zinc Ore Lowered

Joplin, Mo., Dec. 24, 1927

Blende		Per Ton
High		$42.20
Premium blende, basis 60 per cent zinc	$36.00@	37.00
Prime Western, basis 60 per cent zinc		35.00
Slimes and fines, 60 per cent zinc	32.00@	35.00
Average settling price, all zinc		36.94
Galena		
High		$86.60
Basis 80 per cent lead		85.00
Average settling price, all lead		85.42

Shipment for the week: Blende, 10,481; lead, 2,711 tons. Value, all ores the week, $618,730.

By lowering the price offerings on zinc concentrate $1 per ton the buyers have caused a heavier restriction of output probable for next week. Lead ore was heavily loaded from the Oklahoma side of the district this week, to avoid tax assessment on the last day of the year. Purchases totaled but 5,980 tons.

Platteville, Wis., Dec. 24, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$38.75
Lead Ore	
Lead, basis 80 per cent lead	$85.00

Shipments for the week: Blende 1,198 tons: lead 80 tons. Shipment for the year: Blende 63,304; lead 2,045 tons. Shipment for the week to separating plants, 2,270 tons, Blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Dec. 3 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market slack. London, Cornish white, per long ton, £18$\frac{1}{4}$.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Dec. 3 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or c.i.f. port of entry, $100 quoted for first quarter, 1928. Spiegeleisen, 19@21 per cent, $30@$31 f.o.b. furnace.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River: 50 per cent $83.50.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 93@95c. f.o.b. works. Dull.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Dec. 3 issue.

Metal Products

ROLLED COPPER—Sheets, 22$\frac{3}{4}$c.; wire, 15$\frac{3}{4}$@16c. per lb., f.o.b. mill.

LEAD SHEETS—Full rolled 10c. per lb.; clipped, 10$\frac{1}{4}$c.

NICKEL SILVER—29$\frac{1}{4}$c. per lb. for 18 per cent nickel Grade A sheets.

YELLOW (MUNTZ) METAL—Dimension sheets, 19$\frac{3}{4}$c. per lb.; rods 16$\frac{3}{4}$c. per lb.

ZINC SHEETS — 10c. per lb., f.o.b. works.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the Dec. 3 issue.

Steel and Iron Prices Firmer

Pittsburgh, Dec. 27, 1927

Steel-mill operations increased slightly in the last two weeks, but may be off somewhat this week, making the December total about the same as production in the preceding five months. The year's total production of ingots will be about 43,400,000 tons, or 7 to 8 per cent decrease from 1926. Chances are that 1928 will do better, possibly making a new record. The peak production, which in the last four years has fallen in March, is likely to come somewhat later.

Pig Iron—The Valley market shows a moderate movement in foundry iron, and efforts continue to move the minimum up to $17.50. Bessemer, $17.50; basic, $17; foundry $17.25@$17.50 f.o.b. Valley furnaces.

Connellsville Coke—First-quarter furnace coke contracts made recently were chiefly at $2.85 and $2.90, only one being at $3. These prices are believed to involve a wage reduction Jan. 1. Spot: Heating, $2.50@$2.65; furnace, $2.75; foundry, $4@$4.75.

Mining Stocks—Week Ended December 24, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	60⅛	57⅜	59⅛	Oc.15, No.21 Q	0.75
Arcadian Consol	Boston	3⅛	2 3/16	3 1/16		
Ariz. Com'l	Boston	6¼	6⅛	6⅛	Jy. 18, Jy. 30	0.25
Calaveras	N. Y. Curb			1¼		
Calumet & Arizona	New York	115	111¼	115	De 3, De. 9 Q	1.50
Calumet & Hecla	Boston	24¼	21¼	23¼	No.30, De.15 Q	0.50
Cerro de Pasco	New York	72⅛	66⅞	71⅛	Oc.13, No.1 Q	1.00
Chile Copper	New York	44⅛	40⅜	43⅞	De. 2, De. 30, Q	0.62½
Con. Coppermines	N. Y. Curb	7	6	6½		
Copper Range	Boston	21	19	19¾	Ap.2, My.2, A	1.00
Crystal Copper	BostonCurb	*41	*35	*38		
East Butte	Boston	2⅛	2⅛	2⅝	Dec. 1919	0.50
Granby Consol	New York	44⅛	42⅛	44⅛	Jn.15 Jy. 1 Q	1.00
Greene Cananea	New York	149⅛	133⅛	143⅜	Nov., 1920	0.50
Howe Sound	New York	48⅜	43⅛	45⅞	De.31, Ja.16, Q	1.00
Inspiration Consol	New York	22⅛	21⅛	21⅝	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb	3⅞	3½	3½		
Isle Royale	Boston	16	14	15½	Se. 30, Oc. 15, Q	0.50
Kennecott	New York	90⅜	83⅛	88⅜	De. 2, Ja 3 Q	1.25
Magma Copper	New York	58⅜	51⅞	56⅛	De.30, Ja.17 Q	0.75
Mason Valley	N. Y. Curb	1⅛	1 1/16	1⅛		
Miami Copper	New York	20⅜	19¼	19⅜	No.1, No.15, Q	0.37½
Mohawk	Boston	51⅝	49⅛	50	Oc.31, De.1 Q	2.00
Mother Lode Coal	New York	3¼	3	3	De.16, De.31	0.25
Nevada Consol	New York	20⅛	19⅛	20	De.16, De 31 Q	0.37½
New Cornelia	Boston	30	29	29⅞	No.4, No.21 Q	0.50
Noranda	N. Y. Curb	24⅛	23⅛	24		
North Butte	Boston	1⅞	1½	1⅝	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	100	*82	*92	Sept. 1926	0.03
Old Dominion	Boston	13⅛	12	13⅛	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	134⅛	125	134⅛	De.17, Ja.3 Q	1.50
Quincy	Boston	17	16	16⅛	March, 1920	1.00
Ray Consolidated	New York			15⅛	Ap.20, Ap. 30	0.25
St. Mary's Min. Ld.	Boston	32	31	31	Fe.10, Ma.10	2.00
Seneca Copper	New York	3⅛	2	3⅛		
Shattuck-Denn	Boston Curb	*12	*10⅞	*11		
Tenn. C. & C	New York	11⅜	10⅝	11	No.30, De.15, Q	0.12½
United Verde Ex	N. Y. Curb	28⅛	25⅞	26⅛	Ja.4, Fe.1 Q	0.50
Utah Copper	New York	1.62	1.37	1.62	De.16, De.31 Q	1.50
Utah Metal & T	Boston	1⅞	1⅛	1⅝	Dec., 1917	0.30
Walker Mining	Salt Lake	*54	*51	*53		
NICKEL-COPPER						
Internat. Nickel	New York	89⅛	74⅞	87	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	110	110	110	Oc. 13, No. 1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*14¼	*13	*13	June, 1927	0.005
National Lead	New York	133¾	128	132⅛	De. 16, De. 31 Q	1.25
National Lead pfd	New York	115½	115¼	115½	Ja.13, Fe. 1 Q	1.50
St. Joseph Lead	New York	42⅛	41	41	Ma.9, Ma.20, QX	0.75
ZINC						
Am. Z. L. & S	New York	7⅛	7	7	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	43	41½	41½	Nov., 1920	1.50
Butte C. & Z	New York	5	4⅜	5	De. 9, De. 24	0.50
Butte & Superior	New York	11¼	9½	10⅝	De.16, De.31 Q	0.50
Callahan Zn-Ld	New York	1⅞	1⅞	1⅞	Dec., 1920	0.50
Consol.Lead&Zinc'A'	St. Louis	16⅜	14⅛	14¼	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	24⅜	23⅝	23⅛	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati			117¼	Jn.30, Oc.15 Q	1.50
New Jersey Zn	N. Y. Curb	188	184	181	No. 19, De. 10 X	2.00
United Zinc	N. Y. Curb			*55		
Yellow Pine	Los Angeles			*30	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	1⅛	1	1⅛		
Argonaut	Toronto	*33¼	*31	*33		
Barry-Hollinger	Toronto	1.20	1.06	1.19		
Con.W.Dome L.new.	Toronto	*12⅛	*11	*11		
Cresson Consol. G	N. Y. Curb	1⅛	1⅛	1⅛	Se. 30, Oc.10 Q	0.10
Dome Mines	New York	13⅜	12⅜	13	De.30, Ja.20 Q	0.25
Golden Cycle	Colo.Springs	†1.75	†1.72		No.30, De.10 Q	0.04
Hollinger Consol	Toronto	18.50	17.30	18.50	No. 16, De. 2	0.10
Homestake Mining	New York	74	72	74½	De.20, De.27 M	0.50
Kirkland Lake	Toronto	2.57	2.43	2.57		
Lake Shore	Toronto	26.50	26.25	26.50	De 1, De.15 QX	0.20
McIntyre-Porcupine	New York	27¼	26	27¼	De.1, De.1 Q	0.10
Portland	Colo.Springs	†*25	†*20		Ap.6, Ap.15, Q	0.02
Rand Mines	New York			48½	Au.22-29 Am.Sh.	1.52
Teck-Hughes	Toronto	10.70	10.25	10.40	Fe.1, X	0.15
Tom Reed	Los Angeles			*28	Dec., 1926	0.02
Tough-Oakes	Toronto	*72	*67½	*70		
United Eastern	N. Y. Curb	*45	*45	*45	July, 1924	0.05
Vipond Cons	Toronto	*73	*69	*70	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	6.85	5.90	6.40	Oc.17, No.1	0.05
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	18	15½	15½		
Con. Cortez	N. Y. Curb	*18	*18	*18		
Dolores Esperanza	N. Y. Curb	*60	*50	*50	July, 1923	0.05
Premier Gold	N. Y. Curb	2½	2⅛	2⅛	De. 15, Ja. 4	0.08
Tonopah Belmont	N. Y. Curb	1 1/16	1 1/16	1 1/16	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*12	*10	*10	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	2	2	2	Se.20, Oc.21	0.07½
West End Consol	N. Y. Curb	*4	*4	*4	Mar., 1923	0.05
Yukon Gold	Boston Curb	*83	*67	*83	June, 1918	0.02
SILVER						
Beaver Consol	Toronto	2.10	2.00	2.10	May, 1920	0.03
Castle-Trethewey	Toronto	*80	*76	*76		
Coniagas	Toronto	4.75	4.70	4.75	May, 1924	0.12½
Keeley	Toronto	*73	*71	*71	Se.1, Se.15	0.08
Lorrain Trout Lake	Toronto			*60	July, 1925	0.05
McKinley-Dar.-Sav	Toronto	*18½	*18½	*18½	Oct., 1920	0.03
Mining Corp. Can	Toronto	4.10	3.80	4.10	Ja. 10, Ja. 25	1.50
Nipissing	N. Y. Curb	6⅛	5⅛	6⅛	De. 31, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div
SILVER-LEAD						
Ahumada	New York	4⅛	3½	3½	Ma. 25, Ap.4, QX	0.12½
Bingham Mines	Boston	60½	57⅜	57⅜	Ja. 21, Fe. 1 Q	0.95
BunkerHill&Sullivan	N. Y. Curb	152	140	150	No. 24, De. 5 X	0.75
Cardiff M. & M	Salt Lake	97	*93	*96	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	3.00	2.90	2.95	Nov., 1926 Q	0.10
Consti'nMng.&Mill'g	Spokane	*29	*25	*26		
Erupcion	Boston Curb	*50	*50	*50	De.17, Ja.2 Q	0.07½
Eureka Lily	Salt Lake	1.47½	1.27½	1.47½		
Federal M. & S	New York	150	150	150	Jn.25, Jn.29	Spec. $10
Federal M. & S pfd.	New York	95½	94½	95	No. 12 De 15 Q	0.25
Hecla Mining	N. Y. Curb	18⅛	16⅜	18	No.15, De.15 Q	1.75
Highland-Surprise	Spokane	*14½	*12⅛	*14		
Iron King Mining	Salt Lake	*59	*52	*53		
Keystone Mining	Salt Lake			*17	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*26	*26	*26		
Lucky Tiger-Com	Kansas City	†7.75	†7.40		De.10, De. 20 X	0.12
Mammoth Mining	Salt Lake			1.97½	Jn.10, Jn.20 Q	0.05
Marsh Mines	Spokane	1⅜	1⅜	1⅜		
North Lily	Salt Lake	3.80	3.65	3.75		
Park Utah	New York	10⅛	9⅛	10	De. 15, Ja. 3 Q	0.20
Plutus Mining	Salt Lake	2.50	2.25	2.25	Oc. 25, No. 10 Q	0.10
San Rafael	San Fran.	*11⅓	*8	*8⅓		
Silver King Coal	Salt Lake	11.10	10.12½	10.50	De. 24, Ja.2 X	0.35
Silversmith	Spokane	*23	*21½	*21½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*47	*46	*46		
Sunshine M. Co	Spokane	1.20	1.12	1.20		
Tamarack-Custer	Spokane	*60⅜	*49⅓	*60⅜	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.00	12.75	13.00	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	6¼	4⅛	5⅜	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	59	56¼	57⅛	Se. 2, Oc. 1	1.75
Cleveland-Cliffs Iron	Cleveland	110	100	105½	Oc. 15, Oc. 25 Q	1.00
Colorado Fuel & Iron	New York	86⅛	82	82½	May, 1921	0.75
Gt. North'n Iron Ore	New York	24⅛	23⅜	24	Dec. 6, Dec. 28	0.75
Inland Steel	New York	57	55	56⅛	No. 15, De. 1 Q	0.62½
Replogle Steel	New York			12⅛		
Republic I. & S	New York	60⅛	59	59⅜	No. 15, De. 1 Q	1.00
Republic I. & S. pfd.	New York	104	103	104	De. 14, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	126	120	126	De. 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York			110	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	155	146⅛	153⅜	No. 30, De. 30 Q	1.75
U. S. Steel, pfd	New York	140⅜	138⅛	140⅜	Oc.30, No. 29 Q	1.75
Virginia I. C. & C	New York			36	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York			60⅛	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	24	24	24	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	2⅛	2⅛	2⅛		
Alum. Co. of Amer	N. Y. Curb	126	120	123⅞		
Alum. Co. of Amer.pf.	N. Y. Curb	105⅛	104⅜	105	De. 15, Ja1 Q	1.50
Vanadium Corp	New York	67⅛	59⅜	62⅝	No. 1, No. 15 Q	0.75
Patino M. & E	New York	24⅛	22⅛	24⅛	Ap. 27, My. 5	1 sh.
ASBESTOS						
Asbestos Corp	Montreal	33⅛	32⅛	32⅛	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	95	94	94	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport, Texas	New York	105⅛	101	102⅛	Ja.14, Fe.1 QX	1.75
Texas Gulf	New York	78⅛	75⅛	76	De. 1, De. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	49⅜	45⅝	48⅜	No.19, De.1 Q	0.75
Amer. Metal, pfd	New York	113⅛	110⅛	113⅛	No.19, De.1 Q	1.75
Amer. Sm. & Ref	New York	188⅜	175⅛	184⅛	Oc.14, No. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	131	129	131	No., Dec. Q	1.75
Consol. M. & S	Montreal	269	261	266	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	139⅛	125⅛	138⅛	Ja.3, Ja. 17	1.00
U. S. Sm. R. & M	New York	48⅛	46⅛	47	Oc. 6, Oc. 15 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	53	51⅛	53	Oc. 6, Oc. 15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED DEC. 13, 1927

Name	High	Low	Last	Date	Amount	Last Div.
Aramayo Mines (25 frs.)	73/9	71/3	73/9	Nov., 1927	5	p.c. (†)
British Platinum (£1)	—/3	—/3	—/3	Feb., 1925	2½	p.c.
Burma Corpn. (10 rupees)	14.6	13/4½	13/4½	Jan., 1928	6	annas*
Bwana M'Kubwa (5s)	4/4½	3/10½	3/10½			
Camp Bird (2s)	3/—	2/6	2/6			
El Oro (£1)	3/4½	3/—	3/3	Nov., 1924	½	p.c.*
Esperanza (10s)	—/3	—/3	—/3			
Frontino & Bolivia (£1)	14/3	13 1½	13/9	Jan., 1928	5	p.c.
Mexican Corpn. (£1)	8/7½	8/1½	8/6			
Mexico Mines of El Oro (£1)	16/3	15/—	16/3	Dec., 1926	3½	p.c.*
N'Changa Copper Mining	10/—	9/6	10/—			
Oroville Dredging (£1)	4/9	4/4½	4/6	Dec., 1923	3½	p.c.
Ouro Preto (£1)	2/6	2/—	2/3	May, 1925	2½	p.c.
Rhodesian Congo Border (£1)	35/7½	32/6	32/6			
St. John del Rey (£1)	10/4½	9/9	10 —	May, 1927	3½	p.c
San Francisco Mines (10s)	28/10½	27/9	28/—	July, 1927	15s.	
Santa Gertrudis (£1)	17/6	16/9	16/9	Jan., 1928	7½	p.c
Selukwe (2s. 6d.)	9/—	7/1½	9/—	April, 1917	6¼	p.c
S. Amer. Copper (2s.)	1/4½	—/6	—/9	Nov., 1917	75	p.c.
Tanganyika (£1)	66/9	61/3	64 4½	Aug., 1927	7½	p.c.
Union Miniere du Haut-Katanga (Brussels)	10.850	10.485	10.485	July, 1927	182.60	(‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.

Current Prices of Mining Supplies

Rise and Fall of the Market

Current price levels of mining supplies are slightly below those of a month ago or one year ago. Minor advances occurred during December in such materials as track supplies, hollow tile, lumber, manila rope and litharge. The declines existed mainly in steel sheets, cast-iron pipe, nails, and linseed oil. The other materials listed here remained firm at quoted levels.

SHEETS—Quotations are per 100 lb. in various cities from warehouse, also the base quotations from mill:

	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
Galvanized No. 24	$3.60@$3.65	$5.25	$4.80	$5.35	$4.95

STEEL RAILS—The following quotations are per gross ton f.o.b. Pittsburgh, Chicago and Birmingham for carload or larger lots:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh or carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	$2.80	$2.80–$2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	3.90@4.25	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.80	2.85@2.95	3.40	3.75	4.25	2.95

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. Pittsburgh mill, and Birmingham. At other cities listed, quotations apply on less-than-carload lots, from warehouses.:

	Pittsburgh, Mill	Birmingham	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.80	$1.90@$2.00	$3.34	$4.00	$3.25	$3.10	$3.00
Channel, 3 to 15 in.	1.80	1.90@2.00	3.34	4.00	3.25	3.10	3.00
Angles, 3 to 6 in., ¼ in. thick	1.80	1.90@2.00	3.34	4.00	3.25	3.10	3.00
Tees, 3 in. and larger	1.80	1.90@2.00	3.34	4.00	3.35	3.10	3.00
Plates ¼-inch thick	1.80	1.90@2.00	3.34	4.00	3.25	3.10	3.00

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Galvanized iron rigging and guy rope (*add to list*)	12½%

	New York	Cleveland	Chicago
DRILL ROD (from list)	60%	55%	50%

WROUGHT IRON AND STEEL PIPE—The following discounts from list are to jobbers for carload lots at Pittsburgh mill:

	Steel			Iron		
	Inches	Black	Galv.	Inches	Black	Galv.
BUTT WELD—	1 to 3	62	50½	1 to 1½	30	13
LAP WELD—	2½ to 6	59	47½	3 to 6	28	13

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
2½ to 6 in., lap welded	48%	51%	46%

CAST-IRON PIPE—The following are prices on class B and heavier, f.o.b. per net ton, for carload lots:

	New York					
	Current	One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over	$38.60	$50.60	$27.50	$35.70	$33.10	$48.50

NUTS—Hot pressed or cold punched, square or hexagonal, blank or tapped, up to 1-in., inclusive, full kegs or cases, discount 55% from new list, April 1, 1927, at warehouses in New York and vicinity.

HOLLOW TILE—Price per block in carload lots, f.o.b., to contractors, for hollow building and partition tile.

	New York						
	Current on Trucks‡	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco‡	Perth Amboy N. J., Factory
4x12x12	$0.0966	$0.1027	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.145	.1541	.104	.....	.09	.156	$0.2432*
8x12x12	.1812	.1926	.142	.21	.126	.244	.3311†

* 10x12x12; † 12x12x12. ‡ Partition tile

MACHINE BOLTS—Square heads and nuts, up to 1x30-in., full kegs or cases discount 50% from new list, April 1, 1927 at warehouses in New York and vicinity.

LUMBER—Prices wholesale, per M ft. b.m., in carload lots, f.o.b. **San Francisco**—At yards, rough Douglas fir, No. 1 common:

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers alongside dock. Price to contractors, delivered to job, is $5@$10 additional:

	New York		Chicago	
	20 Ft. and Under	22-24 Ft.	Up to 20 Ft., Pine	Up to 32 Ft., Fir*
3x4 to 8x8	$41.00@43.00	$42.00@44.00	$37.00	$39.50
3x10 to 10x10	48.00@50.00	49.00@51.00	45.00	39.50
3x12 to 12x12	55.00@57.00	56.00@58.00	55.00	39.50

Other Cities—Prices are for rough timbers:

	8 x8-In. x 20 Ft. and Under				12 x 12-In ‡ 20 Ft. and Under	
	Pine	Fir*	Hemlock Spruce		Pine	Fir*
Boston	$48.00	$47.50†	$49.00	$52.00	$57.50	$57.00
Cincinnati	50.00	.....	.....	.....	65.00	.....
Denver	.....	32.75	32.75	32.75	33.75	33.75
Minneapolis	42.50	36.75	34.50	.....	47.00	38.75
Kansas City, Mo.	40.50	42.75	.....	.....	54.50	42.75
Philadelphia	48.00	35.00	40.00	45.00	60.00	35.00

*Douglas fir. †Prime. ‡3x12 to 12x12 Chicago S4S.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.50@2.55	$2.95	$3.25	$4.25	$2.83	$4.95
Cut	2.80	.....	4.90	5.00	2.88	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without charge for bags.* Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.25@2.35	$2.35	$2.50@2.60
Chicago, f.o.b.	2.05	2.05	2.10
Cleveland, f.o.b.	2.24	2.24	2.29

LIME—Warehouse; New York quotes bbl. 280 lb. net; Chicago, 180 lb.:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$19.45	$12.10	$3.50	$2.35@$2.50
Chicago	20.00	18.00	....	1.50

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrel (5 bbl. lots)	$0.79½	$0.86½	$0.76	$0.84

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	13.75	15.25	15.25	16.75
White	13.75	15.25	13.75	15.25

HOSE—Quotations at New York warehouses:

Fire Protection 50-Ft. Lengths
Underwriters' 2½-in. coupled, single jacket (net) ..... $0.68 per ft.

Air—Best Grade
¾-in., per ft. ..... 3 ply $0.34 4 ply $0.42

Steam—Discounts from List
First grade ..... 40% Second grade ..... 40–5% Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. for rubber transmission belting. Discounts from list are as follows:
Best grade ..... 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.95
Rubber sheet	.50
Rubber sheet, wire insertion	.80

MANILA ROPE—Per lb., ¾-in. and larger, 1,200-ft. coils:

Atlanta	$0.22	New Orleans	$0.23½
New York	.26	Seattle	.23
Chicago	.23½	San Francisco	.23

EXPLOSIVES—Prices per pound for dynamite in small lots:

	Gelatin	
	40%	60%
New York	$0.265	$0.2875
Minneapolis	.1917	.2123
Denver	.2025	.2275
Seattle	.165	.19
Cincinnati	.22	.245
San Francisco	.1625	.1925

FLOTATION OIL—Pine tar, 50 gal. bbl., gross weight 500 lb., f.o.b. New York, carload lots, per gal. $0.35

CHEMICALS—Prices for round lots in New York market, per lb.:

Zinc dust, 550 lb. casks	$0.09@.10
Litharge, casks	.09
Sodium cyanide, 220 lb. single case lots	.18@.22
Calcium carbide, in drums	.05@.06

Industrial Progress

The Air Separator Improved —New Large Sizes

A RADICAL improvement in air-separator practice has been effected, according to the Rubert M. Gay Company, of New York. An air separator of a new model (No. 27) has been developed which operates on the well-known principle of centrifugal sizing (the dust-laden air being positively and uniformly rotated by revolving vanes in the separating chamber), and has a triple sizing action also. This action consists, first, in a rough sizing by gravity at the distributor plate to remove the very coarse material; second, in a centrifugal sizing in the separating chamber due to the positive fan rotation of the air; and, third, in a more intense centrifugal action as the air passes through the fan path. The addition of this third sizing zone in and within the fan path is something new.

The first sizing, which is similar to that used in all air separators, is only a preliminary step, as the bulk of the material is carried into the separating chamber, where most of the coarse material is rejected; it then passes into the fan path and the third sizing zone in which the final separation is accomplished. This triple separation gives extremely sharp sizing, reduces the fines in the tailings to a point never before approached, greatly increases the capacity, and reduces the power required per ton of finished material, the manufacturer claims.

The new centrifugal fan has step adjustments which give variations of less than one-half of 1 per cent in the fineness of product, in addition to which are several hundred different steps covering the entire range from 60 to 350 mesh and on to microscopic sizes. Adjustments can be made in two or three minutes. Any adjustment can be returned to at any time with the assurance that the product will be exactly the same as at the previous similar adjustment.

The speed of the separator is never changed nor is the air velocity choked by dampers to vary the product.

This separator is an entirely new machine and is of extremely heavy construction: the plate work is reinforced with angles and channels for stiffening and bolting together. The cones have very steep angles to prevent damp material from building up, with rapping plates and knocker rods for use when extremely sticky materials are handled.

Oil-tight drive heads of massive construction inclose all of the working parts. These include oversize steel gears, roller thrust bearings and main bearings. The drive head is supported on heavy angles and I-beams which rest on the supporting framework and in the larger sizes are trussed. No driving strains or vibration are transmitted to the separator casing. This casing acts only as a collector for the fine material.

All of the working parts are flooded with oil, which is collected, filtered, and returned to the reservoir without waste and without use of a pump or other moving parts. This oiling system is said to be fool-proof, requiring a minimum of oil and no attention other than the addition of a little oil to the tank occasionally as indicated by the gage glass. There are no oil or grease cups.

The new model is built in eight sizes ranging from 30 in. to 18 ft. in diameter with capacities up to 50 tons or more per hour. The 16- and 18-ft. sizes are something new in the separating field. Formerly it was found that variations in different parts of the separating area around the distributor plate were so great that it was not thought advisable to go beyond 10 or 12 ft. in diameter and 14 ft. was the limit. The centrifugal separator, however, is based on an entirely different principle, and there is no limit to its size, for the reason that the air can be rotated just as positively in a 20-ft. as in a 2-ft. machine.

The 16- and 18-ft. separators, furthermore, are not simply 14-ft. machines with larger casings, but they are of heavier design throughout and are built for the hardest duty. The driving heads, shafts, and other parts of the driving assembly are three to four times as heavy as on any 14-ft. air separator. The weight of the rotating parts is carried on a thrust bearing capable of carrying a load of 150 tons.

Pulling Plugs

A small device, the use of which is intended to avoid the accidents sometimes experienced in pulling plugs, has been introduced by the Ren Manufacturing Company, 553 Main St., Winchester, Mass. This tool is known as "Pull-A Plug" and may readily be slipped on to standard plug-caps of any size or style. It is quickly fastened by tightening a screw, and has two curved arms which act as grips for the fingers. The device also serves as a shield, protecting the plug-cap from breakage.

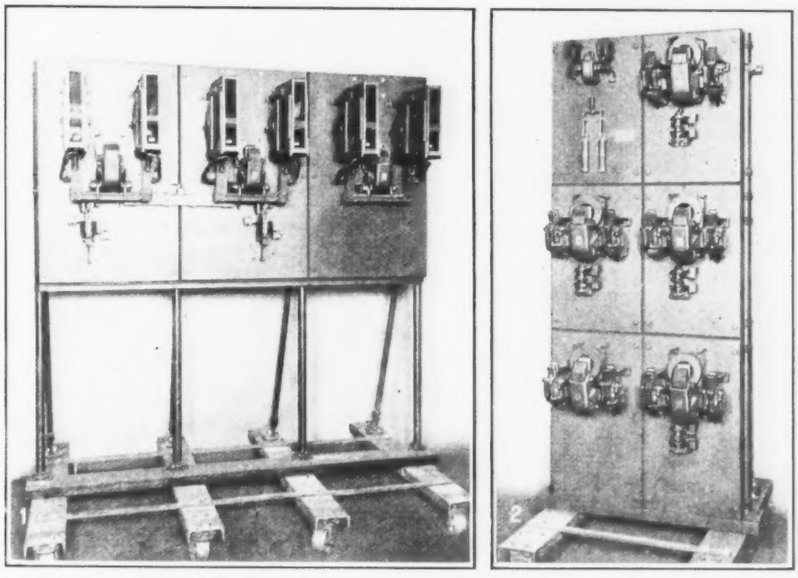
Magnetic Mine Hoist Control of New Design

AN ENTIRELY new line of magnetic control for mine hoist service has been developed by Westinghouse. All contactor panels in it are 76 in. high, so that they will line up properly with standard switchboard panels 76 in. high. They are provided, also, with channel-iron sills.

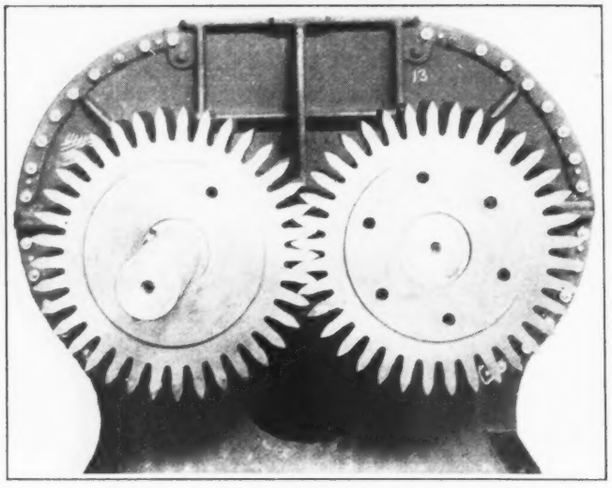
The high voltage air-break reversing contactors are provided with current interlocks to prevent one contactor from closing until the arc has been completely extinguished on the contactor being opened. Both high- and low-voltage reversing contactors are mechanically interlocked.

In this new development of high-voltage reversing contactors the two-pole design has been retained for space and safety considerations. The connection of the two pole contactors provides opening of all power leads to the motor stator and insures against overwinds as the opening of any two-pole contactor opens two phases of the line.

The arc-rupturing ability of these high-voltage contactors provides reliable operation even under adverse conditions. The contactors are of the floating-armature construction and are self-aligning.



1. View of 2,200-volt primary reversing panel of new improved magnetic mine-hoist control. 2. Six-point secondary control panel of new control



The flexible tooth gearing shown here permits this blower to be operated at higher speeds and against higher pressures than have heretofore been practiced at the higher speeds

Flexible Tooth Gearing for Blowers

BLOWERS of the rotary positive type have been used with pneumatic flotation processes since the early experimental installations, these earlier blowers being of such design that operating speeds were low. Advancements in design of blowers have permitted some increase in these speeds, but blowers for medium and larger capacities were still driven through belt, gears or other reducing mediums from electric motors.

During the past year, however, J. T. Wilkin, president and chief engineer of the Connersville Blower Company, Connersville, Ind., has developed and patented a flexible gear tooth system, including a modified tooth form of unconventional design, by which three or more pairs of teeth are in contact at all times; also in which there is a circumferential yielding of each pair of contacting teeth that compensates for any departure from theoretical accuracy at the point of contact. This yielding is distributed throughout the length of the tooth and its extended root, so there is no local concentrating of stress that might result in ultimate rupture of the tooth.

This system of flexible tooth gearing, along with high inertia impellers and renewable split-sleeve bearings, has been incorporated in a new heavy duty blower produced by the Connersville company, which may be operated at higher speeds and against higher pressures than have heretofore been practical at the higher speeds. Direct-coupling to motors running at their most efficient speeds is now feasible even in blowers of larger capacities.

Another Transit Available for Surveyors

A NEW precision transit for mine and other work has been developed by the Warren-Knight Company, of Philadelphia, makers of the "Sterling" line of surveying instruments. The new instrument is of medium size and weight and combines the same structural features as the larger precision transit made by the company.

Some departures from usual construction are to be noted in the "Sesqui" model, as the new transit is called. As set forth by the maker these are as follows:

The tripod plate has a corrugated edge affording a convenient hand hold for setting up or taking down the instrument. The leveling head has eight reinforcing ribs and is non-cramping, permitting the instrument to be rocked through the full angular tilt of one pair of screws without releasing the other pair, thus greatly decreasing set-up time.

The horizontal limb of hard bronze is $5\frac{1}{2}$ in. in diameter at the graduated edge and reinforced with 24 full-length, deep radial ribs about $\frac{1}{4}$ in. deep on the under side of the limb. These ribs afford a convenient finger hold in setting the limb to the vernier and keep it from being bent even with unusually severe blows.

Graduations are on a sterling silver ring, and the figures on the limb and verniers are differentiated by both size and slant to indicate the correct direction of reading.

The top plate, also of hard bronze, has a triple system of ribbing, insuring adequate protection for the horizontal limb and rigid support for the standards.

Radial ribs extend to the extreme edge of the plate, beneath and beyond the standards, and one rib is carried on a line with each of the screws securing the standards. Two sets of cross ribs, about $\frac{3}{8}$ in. deep, are provided, which are carried in line with the standards on the under side of the plate serving as trusses and giving the advantages of the one piece U-shaped standards without the disadvantages, uncertainty of fitting, and unequal tension usually present in that type.

Standards are of hard bronze having a deep "L" section ($1\frac{1}{8} \times \frac{9}{16}$ in. at the base) with a wide and heavy footing block which enables them to be securely fastened to the top plate entirely free from internal strain.

The telescope axle is of hard bell metal of sturdy design having cylindrical pivots which rest in V bearings in the standards. The standard top pieces do not touch the telescope axle at any point. It is possible to use this type of axle and bearing satisfactorily only in an instrument having centers, plates, and standards sturdy enough to eliminate a brace across the top of the standards.

The use of the cylindrical bearings results in permanence of adjustment, and in reduced maintenance and repair costs (it is not necessary to fit the bearings); it eliminates the use of the telescope axle clamp for tension on the telescope axle, and makes it easier to adjust (by means of opposing capstan nuts without touching the screws in the standard top plate) when adjustment is necessary.

A right-angle peep sight through the telescope axle and a center point for plumbing from above are provided. The telescope is 10 in. long, balanced and dust proof, with $1\frac{1}{4}$ in. objective and magnifying power of 22 diameters. The lenses are imported and afford a bright flat field with abundant light, and permit an absolutely sharp focus as close as four feet.

The telescope level is so located as to afford an unobstructed view of both ends of the bubble. The level vial is 5 in. long and has a uniform degree of sensitivity (about 40 sec.), enabling the instrument to be used for extremely accurate leveling work even at long distances.

The new transit weighs about 13 lb., less than the usual full size instrument and more than the usual light transit.

Large Synchronous Converters for Zinc Company

THE Norwegian Zinc Company (Det Norske Zinkkompani), of Norway, is planning to install some of the largest synchronous converters ever built. Its new equipment will include four converters, which are 18-pole, 5,800-kw., 167 r.p.m., 400/580 volt, 10,000-amp., 25-cycle and shunt-wound, and are continuously rated with 40 deg. C. temperature rise; and four transformers, which may be described as being forced-air cooled, 25-cycle, 6,100-kva., 12,000-volt primary and 435-volt secondary, 3 phase primary and 6 phase secondary, indoor type, with load ratio control equipment for changing taps under load. Also included in the equipment is a 750-kw. synchronous motor-generator set for starting the converters, together with complete switchboard equipment.

These are the largest converters which have been supplied with this method of direct-current voltage control, according to the General Electric Company, which is supplying them.

The new installation will be used for the electrical reduction of zinc ore. Twenty-five cycle, 12,000-volt alternating current will be converted to 400- to 580-volt direct current. The variation in the last-mentioned voltage is accomplished by the load ratio control equipment provided with the transformers.

Sales Offices Throughout the World

Birmingham, Ala.
Butte, Mont.
Chicago, Ill.
Duluth, Minn.
El Paso, Texas
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Knoxville, Tenn.
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Melbourne, Australia
Sydney, Australia
Brisbane, Australia
Newcastle, Australia
Auckland, New Zealand
Wellington, New Zealand
Montreal, Canada
Nelson, B.C., Canada
Cobalt, Ont., Canada
Vancouver, B. C., Canada
Tokio, Japan
Johannesburg,
Transvaal, S. Africa

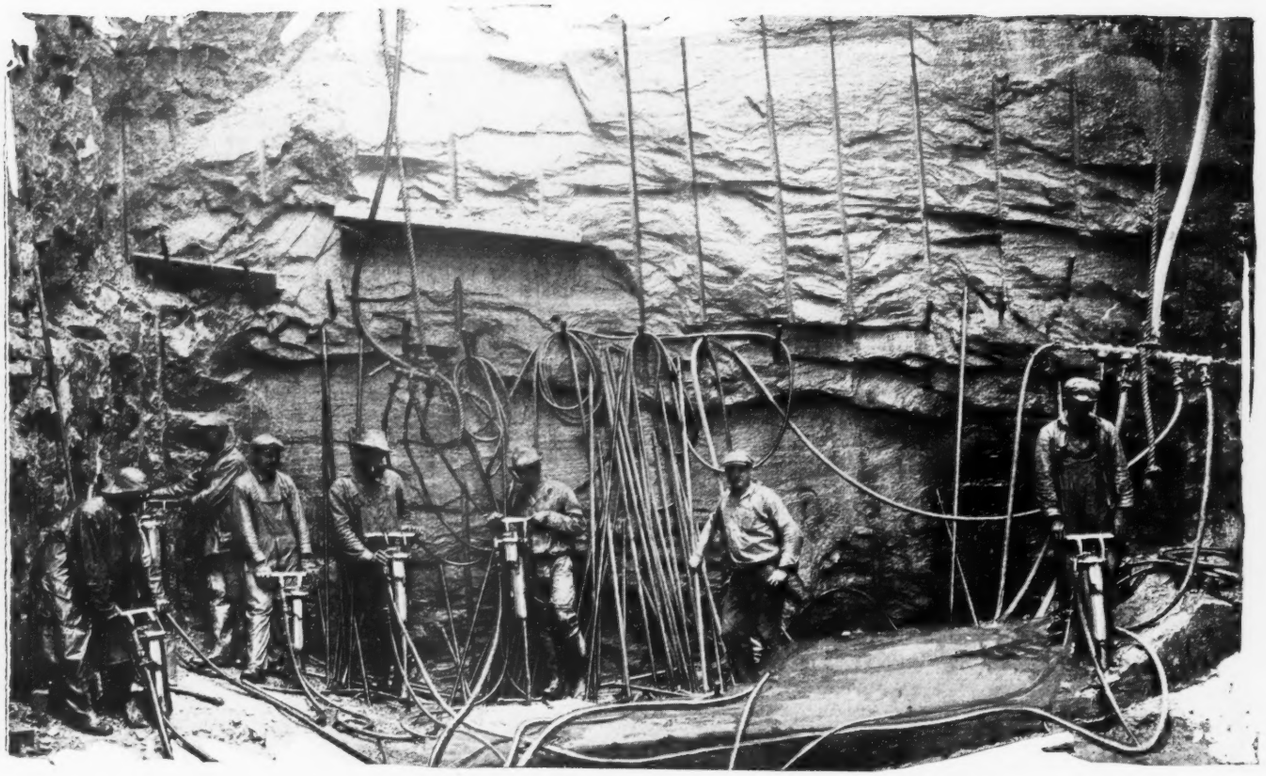
The merger of the Gardner Governor Company and the Denver Rock Drill Mfg. Company has made Gardner-Denver Products easy to buy. No matter where users of compressors, pumps and air actuated tools are located, the many sales and service offices of this new company, located in the principal industrial centers of the world, put at their disposal the services of experts who, in turn, are backed by two enormous plants and sixty-seven years of manufacturing experience.

GARDNER-DENVER COMPANY

QUINCY, ILL. · · · *Headquarters at* · · · DENVER, COLO.

SALES OFFICES THROUGHOUT THE WORLD

GARDNER-DENVER



CP-5 Sinkers at bottom of shaft on Welfare (formerly Blackwell's) Island. Patrick McGovern, Inc., contractor

Patrick McGovern, Inc., *uses* CP Sinkers *on N. Y. Subway Contracts*

EXTREMELY hard rock and limited time necessitated the use of heavy sinkers on this shaft. Selected after critical competitive tests, CP-5 Sinkers are proving the wisdom of their purchase. Mounted on shells, these same drills are now used as drifters in the tunnel headings proper. CP-10 Sinkers were selected for blockholing and bench work. Over 100 CP Drills have been purchased by the McGovern Company to date. Numerous contractors and mining companies with heavy sinking and drifting to do, have found the CP-5 an ideal machine because of the easy change from hand type to shell mounting (or vice versa) in a few moments.

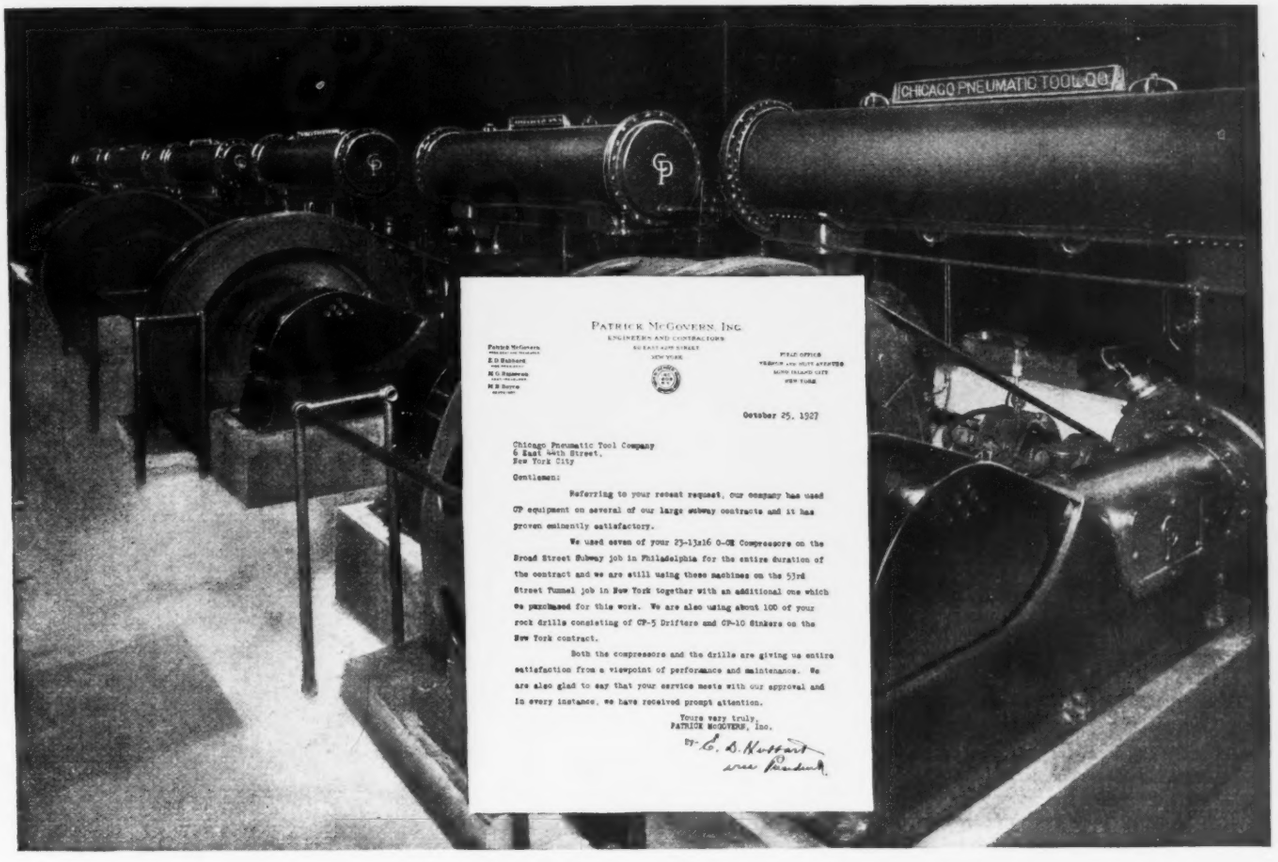
We will gladly demonstrate the superiority of CP Rock Drills to any prospective user.

Chicago Pneumatic Tool Co.

Sales and Service Branches all over the world

R-125

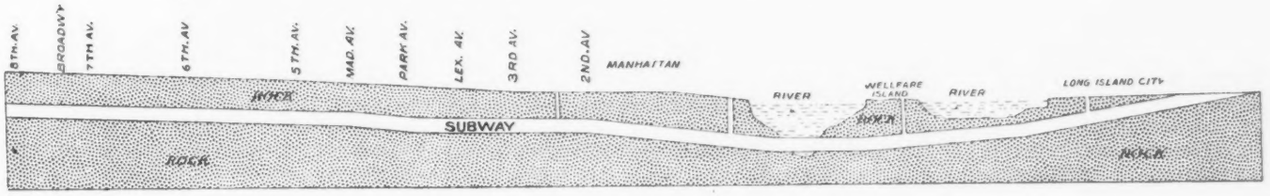
6 East 44th Street New York, N. Y.


CHICAGO PNEUMATIC TOOL CO.
PATRICK McGOVERN, INC.
ENGINEERS AND CONTRACTORS
October 25, 1927
Chicago Pneumatic Tool Company
6 East 44th Street,
New York City
Gentlemen:
Referring to your recent request, our company has used CP equipment on several of our large subway contracts and it has proven eminently satisfactory.
We used seven of your 23-1½x16 O-CE Compressors on the Broad Street Subway job in Philadelphia for the entire duration of the contract and we are still using these machines on the 53rd Street Tunnel job in New York together with an additional one which we purchased for this work. We are also using about 100 of your rock drills consisting of CP-5 Drifters and CP-10 Stinkers on the New York contract.
Both the compressors and the drills are giving us entire satisfaction from a viewpoint of performance and maintenance. We are also glad to say that your service meets with our approval and in every instance, we have received prompt attention.
Yours very truly,
PATRICK McGOVERN, Inc.
By C. S. Huttart
Vice President

Six CP Compressors photographed in the Patrick McGovern compressor house at 53rd St. and East River, New York City. They are operating efficiently and economically, day and night.

PATRICK McGOVERN, Inc., like an increasing number of industrial firms and engineers throughout the world, has placed the seal of approval on CP Air Compressors. After all, QUALITY DOES COUNT. If you have a compressed air problem, our engineering staff is at your disposal.

Eight CP Compressors are supplying the air required in the construction of New York's Subway Extension from 8th Ave. across 53rd Street, under East River and Welfare Island, to Long Island City. Seven of these compressors were used in constructing the Broad Street Subway, Philadelphia, and are today operating like new.



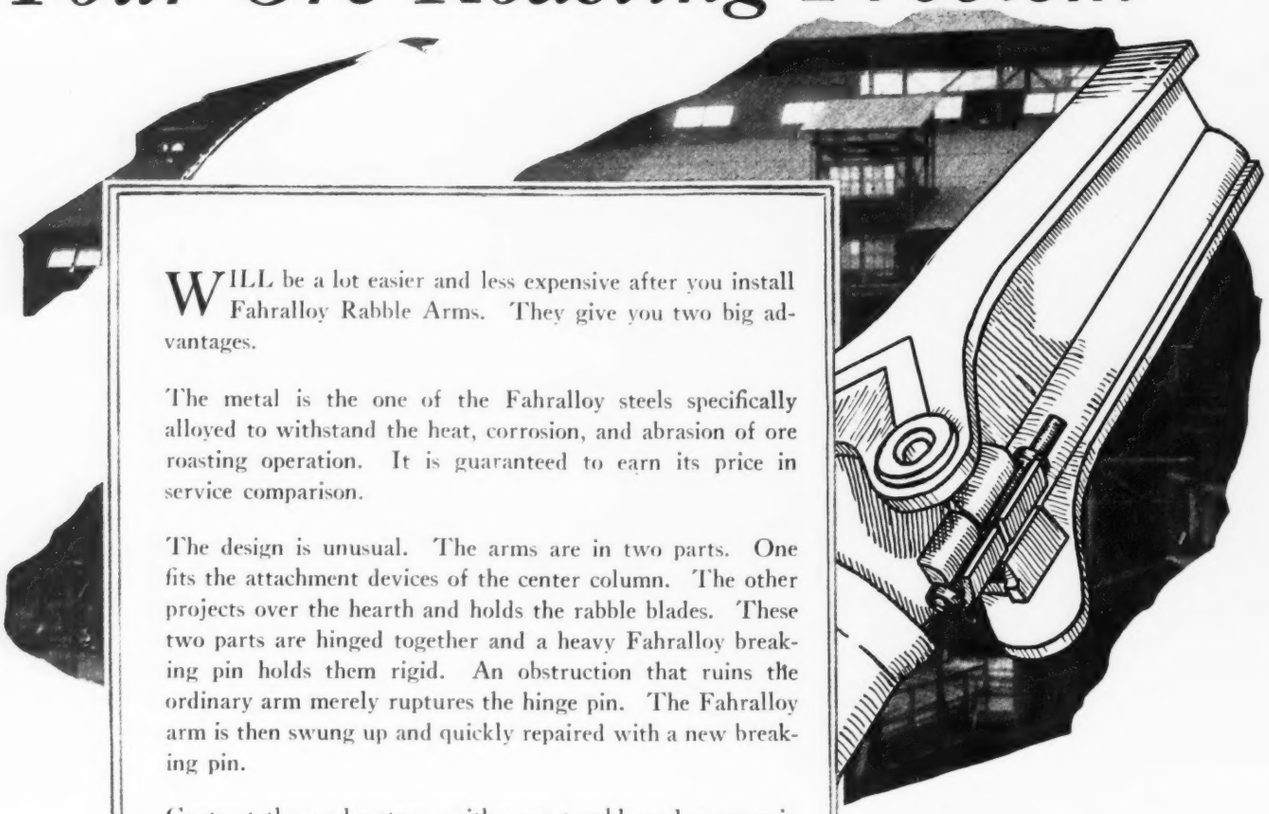
Chicago Pneumatic Tool Co.

Sales and Service Branches all over the world

6 East 44th Street New York, N. Y.

C-276

Your Ore Roasting Problem



WILL be a lot easier and less expensive after you install Fahralloy Rabble Arms. They give you two big advantages.

The metal is the one of the Fahralloy steels specifically alloyed to withstand the heat, corrosion, and abrasion of ore roasting operation. It is guaranteed to earn its price in service comparison.

The design is unusual. The arms are in two parts. One fits the attachment devices of the center column. The other projects over the hearth and holds the rabble blades. These two parts are hinged together and a heavy Fahralloy breaking pin holds them rigid. An obstruction that ruins the ordinary arm merely ruptures the hinge pin. The Fahralloy arm is then swung up and quickly repaired with a new breaking pin.

Contrast these advantages with your trouble and expense in keeping your furnaces going with rabble arms of ordinary metal and usual construction.

Your request will bring Bulletin F, describing other Fahralloy uses in Ore Roasting mechanisms.

SOUTHERN MANGANESE STEEL CO.

(Subsidiary of American Manganese Steel Co.)

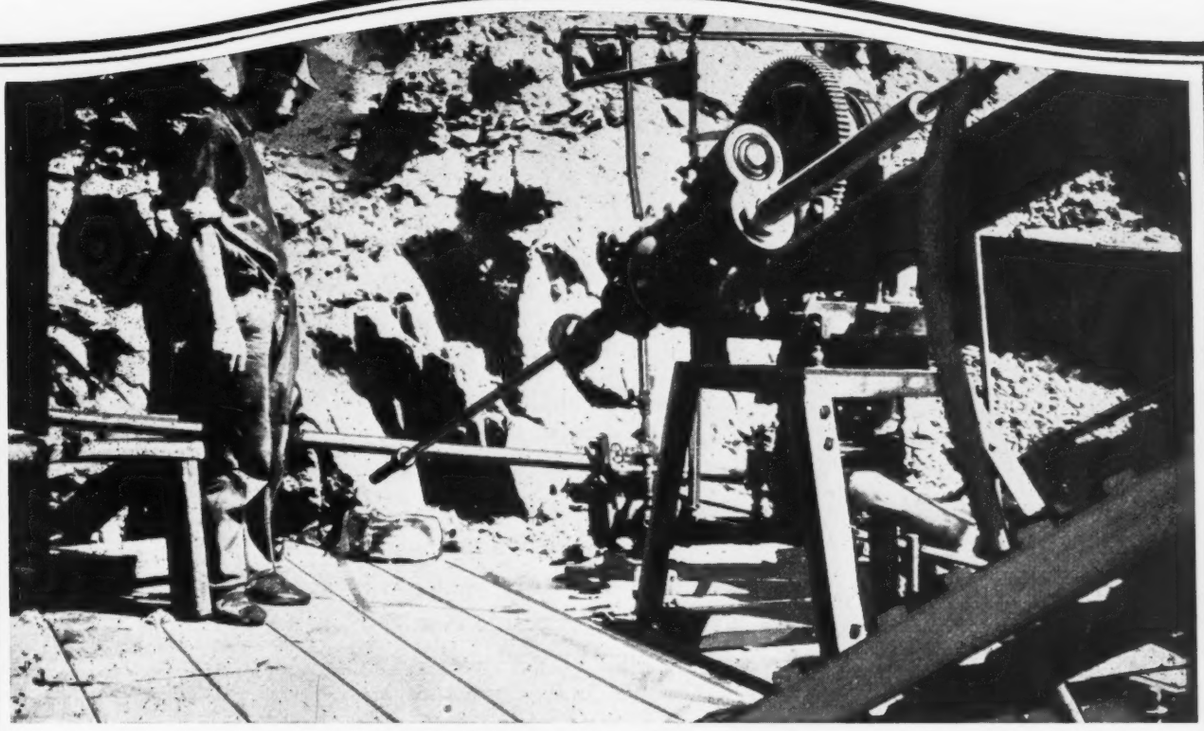
Foundry and Gen. Offices: 6600 Ridge Ave., St. Louis, Mo.

New York Chicago Pittsburgh Cleveland Detroit
Denver Oakland Los Angeles Newcastle, Delaware

The mining industry uses these Fahralloy heat and corrosion resisting castings: **Rabble Arms and Blades; Grates for Sintering Machines; Furnace Grates; Stoker Parts; Furnace Doors; Dampers; Baffle Plates; Burners; Tuyeres; Discharge Spouts; Muffles; Retorts; Rotating and Cylindrical Pumps for Corrosive Liquids.**

AMSCO Fahralloy

FOR ORE ROASTING



One of the Longyear Diamond Drills Set Up for Drilling an Angle Hole

32,000 Feet Of Diamond Drilling

OVER 32,000 feet of diamond core drilling with five Longyear drills on three different contracts is our record for one client, with a large amount of drilling still to be done. Obviously, this company finds satisfaction in the four cardinal points of Longyear drilling service:

(1) Good progress and competent results through experienced men and suitable equipment.

(2) Reasonable costs as a result of skillful management and selection of crews and equipment.

(3) Business-like handling of the job without trouble or annoyance.

(4) Responsibility proven by thirty-five years of drilling experience all over the world.

You will find it of advantage to contract your drilling to the Longyear company. Write for quotations on large or small jobs.

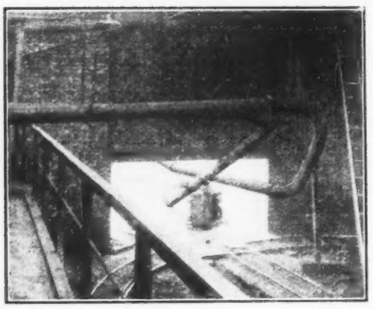
Other activities include diamond drill manufacturing, shaft sinking and mine development.

E. J. Longyear Company

Minneapolis, Minnesota, U.S.A.

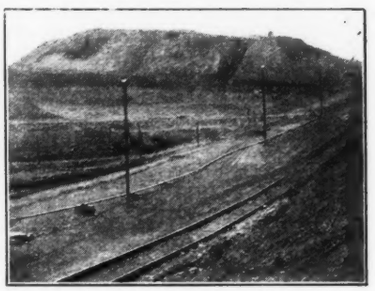
"FOR EVERY JOINT ON THE LINE"

VICTAULIC COUPLINGS

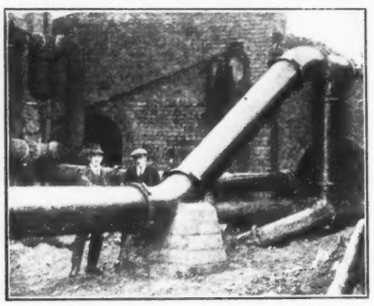


1.—10-in. rising main

VICTAULIC COUPLINGS are regularly specified for compressed air and water lines in hundreds of mines, for thousands of miles of oil pipe lines and for natural and manufactured gas lines, for water supply and sewage lines, for molasses lines and for many uses in process products manufacture.



4.—2½-in. emergency line laid in an hour—no leaks



2.—20-in. circulating line for condenser plant

Victaulic Couplings greatly reduce the cost of pipe laying due to the ease and speed of installation by unskilled labor. They are flexible under pressure or vacuum and provide for the expansion and contraction of the line.

Available for all sizes of steel, wrought iron, and cast iron pipe—for all pressures from vacuum to ten tons per square inch.

5.—In the oil fields

3.—12-in. oil line

For list of uses and users, typical installations and detailed information, write for Victaulic "Bulletin No. 4." Inquiries are invited—estimates gladly submitted.

6.—20-in. gas line

All-purpose couplings

VICTAULIC COMPANY OF AMERICA

26 Broadway New York

FLEXIBLE— LEAK-PROOF

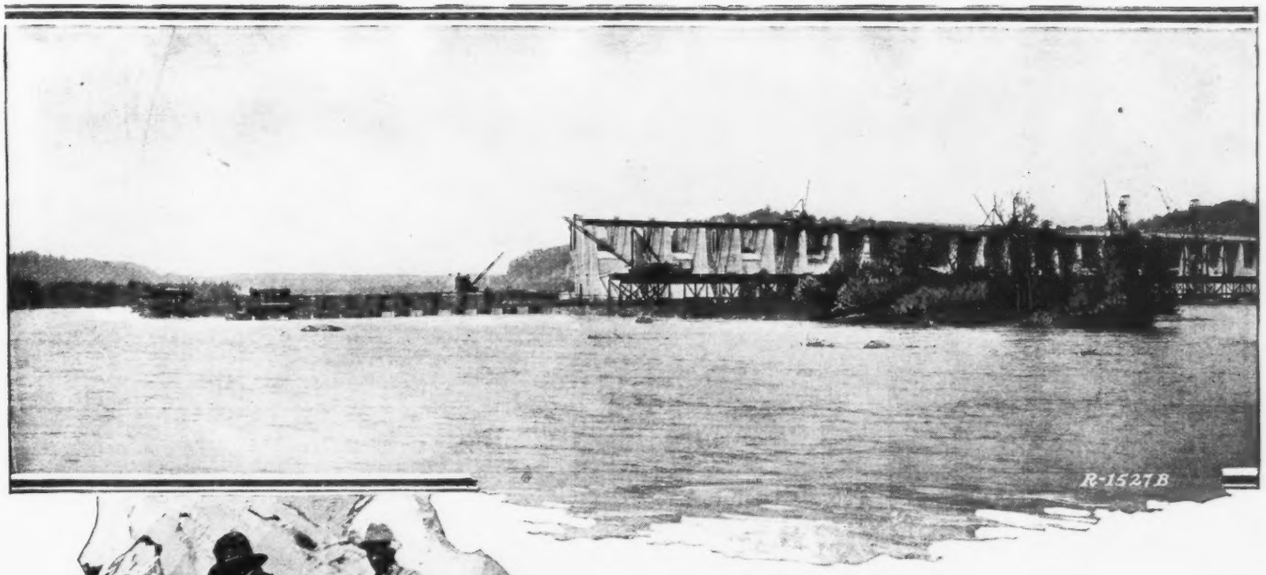
VICTAULIC

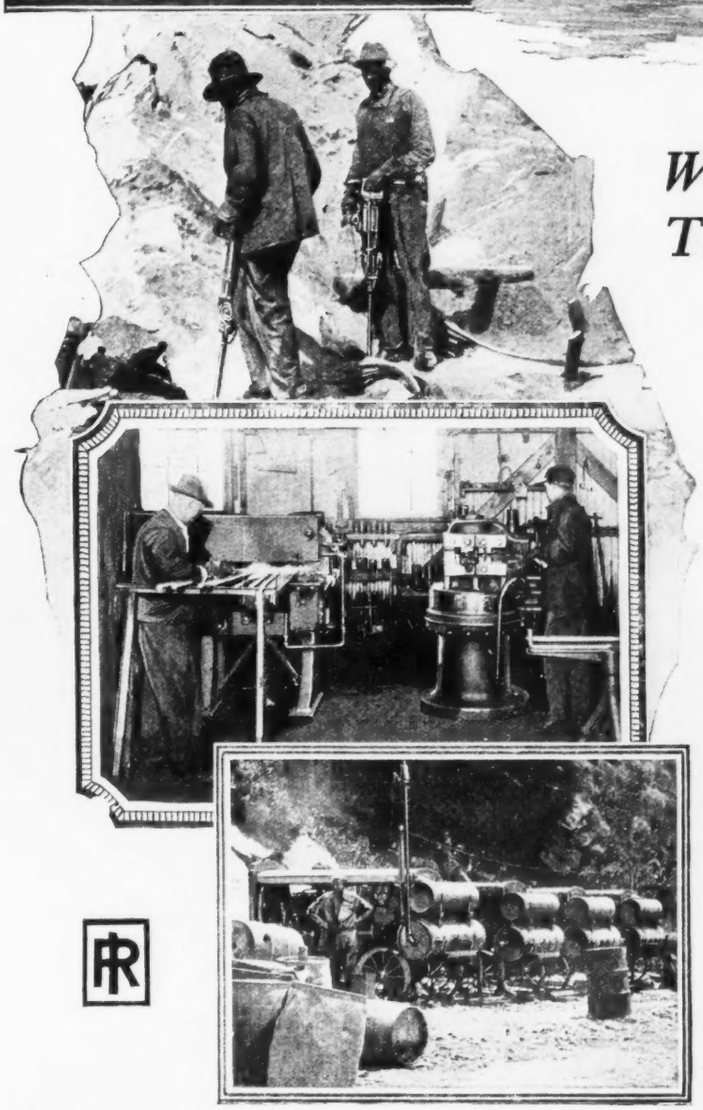
REG U.S.PAT OFF

PIPE COUPLINGS

"For every joint on the line"

FOR OIL, GAS, WATER, SEWAGE, COMPRESSED AIR, Etc.





Working Against Time and Tide on the Conowingo Dam

TO WORK successfully against seasonal high water, is the problem of the Arundel Corporation, Baltimore, who are associated with Stone & Webster, Inc., in the construction of the Conowingo dam spillway.

This hydro-electric project is being designed and constructed by Stone & Webster, Inc., under the direction of Wm. C. L. Eglin, Vice-President and Chief Engineer of the Philadelphia Electric Company. The abutment on the east bank and the spillway are being constructed by the Arundel Corporation. The work involves the expenditure of millions of dollars and the services of several thousand men. Such an undertaking demands the use of the most dependable and economical machines so that the most rapid progress can be made.

Three Ingersoll-Rand XCB-2 Compressors supply most of the compressed air, while portable Compressors are used at the distant points or where extra air is required. The drilling is entrusted to I. R. "Jackhamers", Paving Breakers and deep hole drills, while "Leyner" sharpeners and oil furnaces account for a plentiful supply of sharp, properly made drill steel.

The Arundel Corporation is also relocating 16 miles of railroad on the bank of the Susquehanna River. This work is being done for the Columbia and Port Deposit Branch of the Pennsylvania Railroad.

INGERSOLL-RAND COMPANY
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THE 59TH ANNUAL REVIEW AND YEAR BOOK *of* ENGINEERING AND MINING JOURNAL

JANUARY 21, 1928

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Our Copy Service Department will gladly assist you in the preparation of an effective advertising suggestion. Two colors are available at low club rates if desired.

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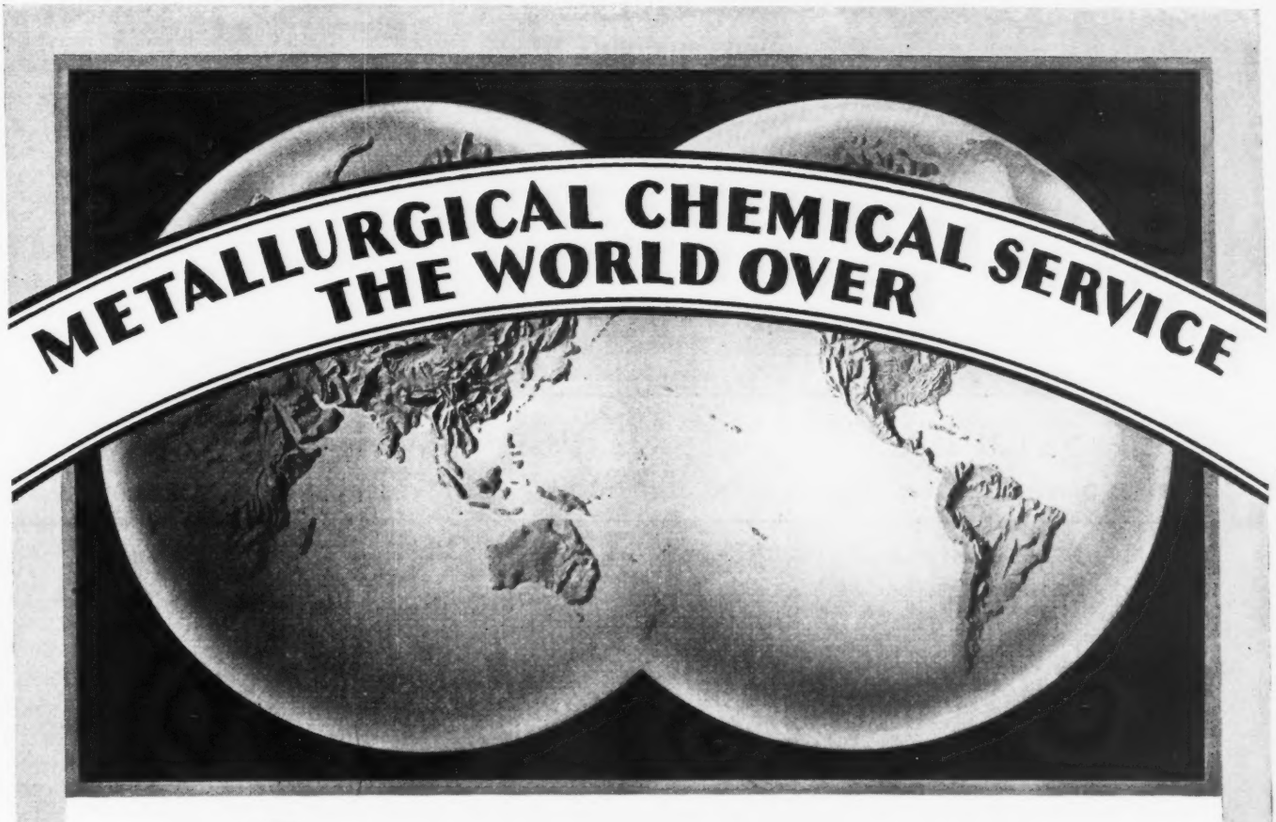

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with a water tube that can be cleaned or renewed in five minutes

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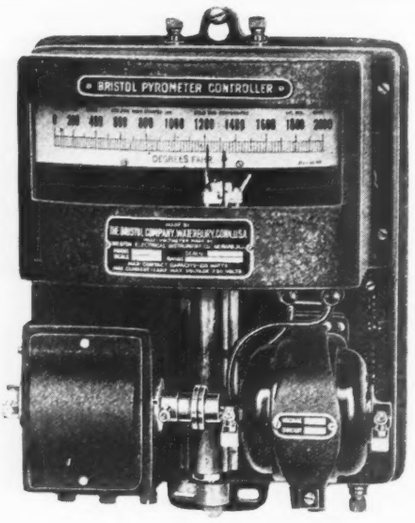

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Keep your drill bits in a clean and sharp condition by *better* tempering.

Harder cutting edges, cut more rock or ore per day —because they work faster and less time need be lost in replacing drilled bits.

The best blacksmiths do their best work when the temperature of their forges is automatically taken care of by

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This reliable equipment relieves the men from the detail of adjusting the fires and permits them to concentrate upon their work in drawing uniform temper in the drill steel.

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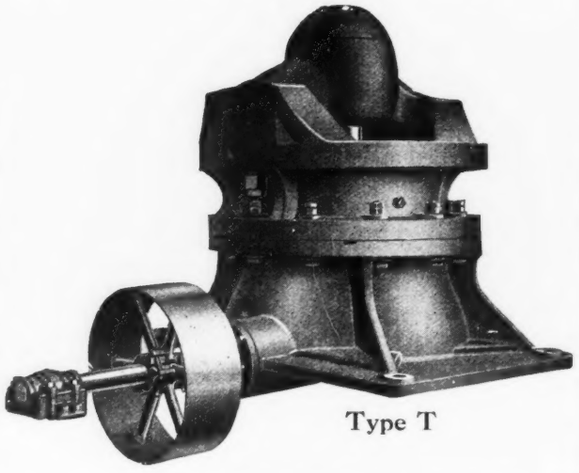
Finishing Gyratory



Type T

Puts the "finishing touch" on crushing—

Built for finer crushing, this machine has all the sturdy qualities of its "big brother," the standard Bulldog Gyratory.

A shorter head and vertical concaves produce a crushing angle which permits driving at about one-third higher speed than the standard machines—and secures for the owner larger tonnages to smaller sizes.

Built in Sizes $4\frac{1}{2}''$, $6''$, $10''$, $15''$, $20''$.

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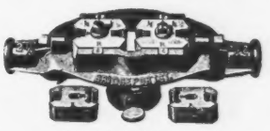

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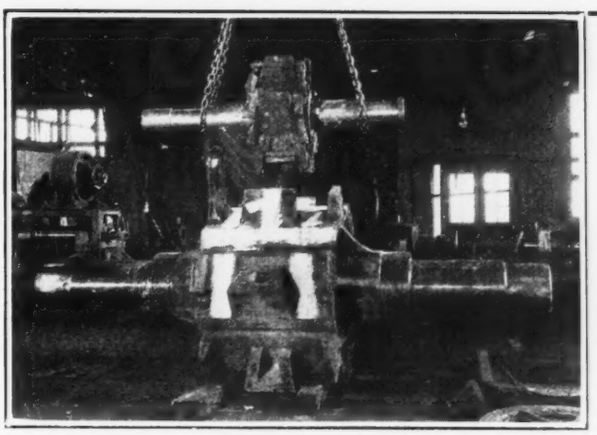

Spare Parts for Any Dredge—Anywhere

The above picture shows upper tumblers for dredges of 2½ cubic feet and 18 cubic feet capacity made in our Marysville plant. We are prepared to supply any parts whether large or small for any make of dredge in any part of the world.

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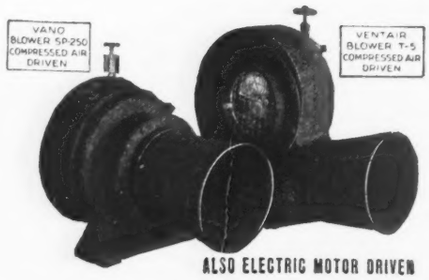

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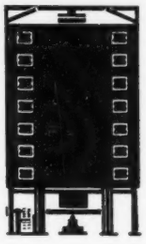

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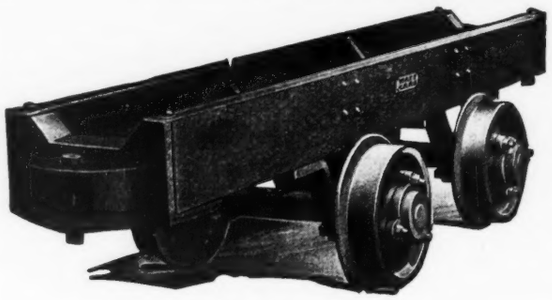

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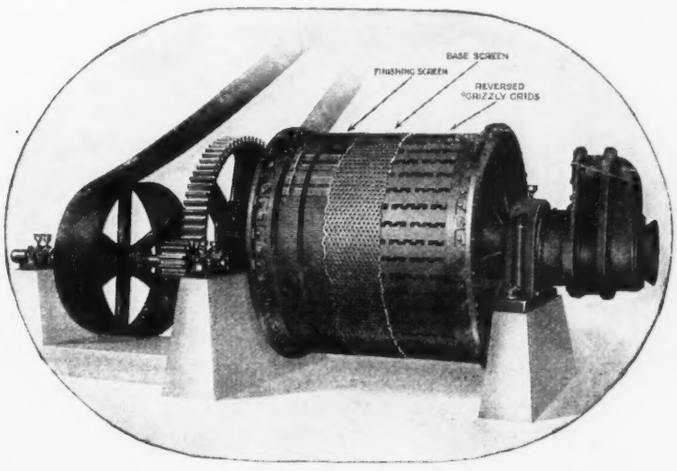

Herman Mills do a better job in *one* simple, compact unit than *four* stages of rolls in taking a 2-in. round ring crusher product down to ten mesh. By using a Herman Mill all auxiliary equipment incident to the operation of rolls is eliminated. The Herman Mill is used in many installations to replace the former method of intermediate crushing—they discharge as they grind—thus the product is extruded automatically and continuously. Proper grinding of an ore is reflected in a higher recovery of values.

Investigate this mill's application to your own problems.

Grinds, Screens, Discharges
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Manufactured in eight sizes with capacities from 3 to 300 tons in 24 hours.

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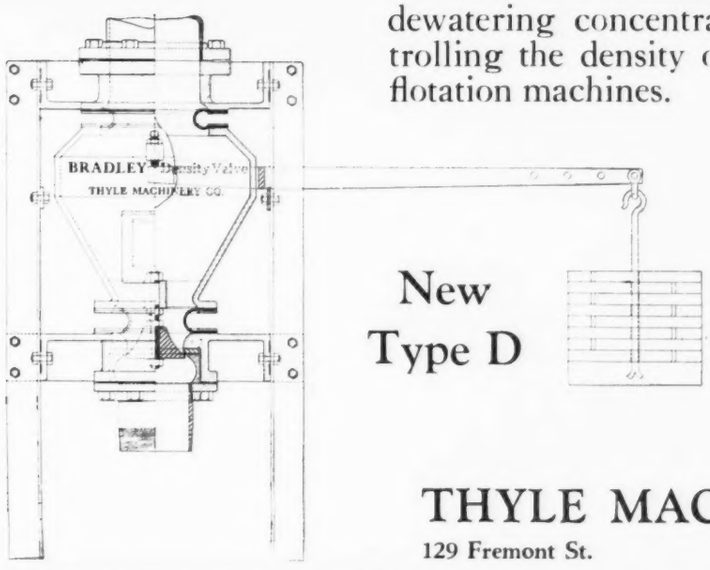
Now a Larger Size—Type D—
Bradley Automatic Density Valve

To meet the demand for large capacity plants in dewatering concentrates and tailings, likewise controlling the density of feed to regrinding units and flotation machines.



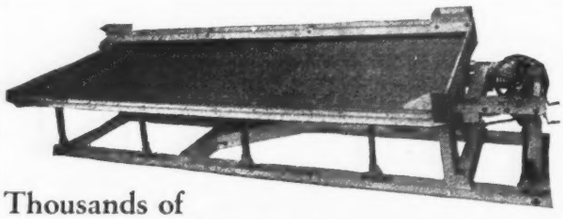
New Type D

The construction of the Type D is quite similar to the standard sizes of Bradley Automatic Density Valves, with the exception, the connecting hangers are made of steel, and the vertical movement of the floating pot is much greater in proportion.

Type D is but a development of the Type A Valve, which is giving such satisfactory results in securing uniform density feed to agitators, filters, and flotation and grinding units.

THYLE MACHINERY COMPANY

129 Fremont St. San Francisco, Cal.



Thousands of Overstrom Universal Concentrating Tables Testify to its success.

Unequalled in its capacity and recovery—handles material from 4 mesh to slimes—whole deck area effective—simple—motion keeps concentrates away from upper side of rifles, allowing only sand to wash over—great capacity—little power. Send for Bulletins 150.

Superior Mining Machinery

Standard or Sectionalized

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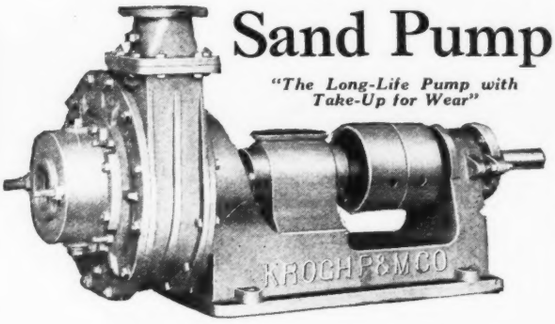
"The Long-Life Pump with Take-Up for Wear"



To adjust a worn liner

merely tighten two nuts on the suction nozzle, when the pump is running. Write for new Bulletin 98.

We continue to manufacture the old type Krogh open runner sand pump, so popular in the industry.

The Krogh Pump & Mach. Co.
147 Beale St., San Francisco

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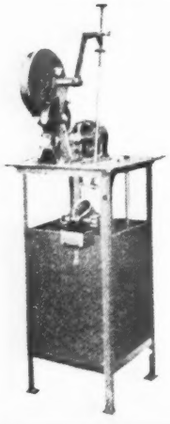
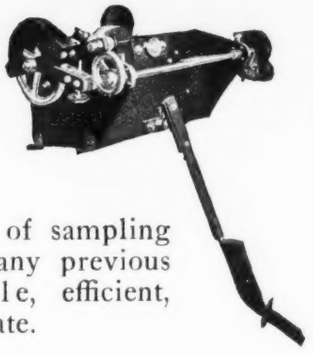


Every mill needs them



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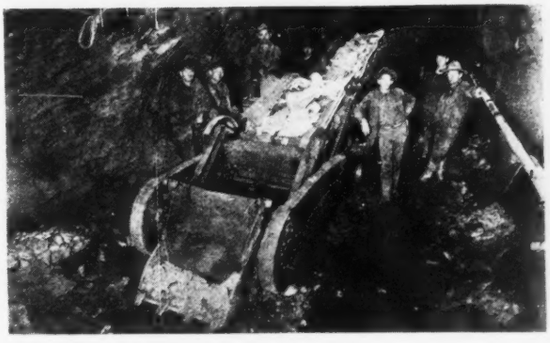

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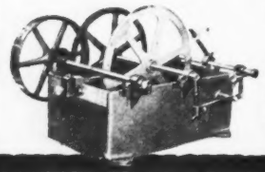

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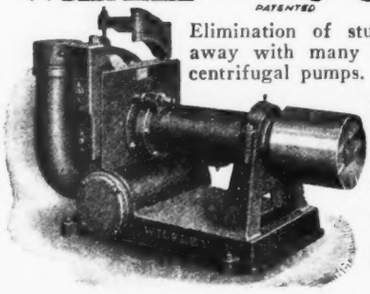

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Pump maintains extraordinary efficiency.

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Cleaning out pump or changing wearing parts requires only a few minutes.

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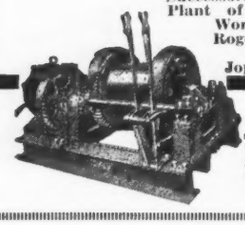

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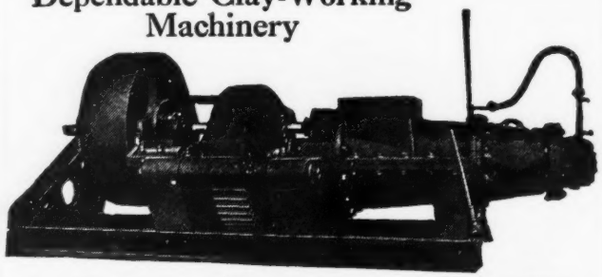

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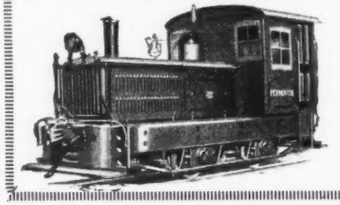

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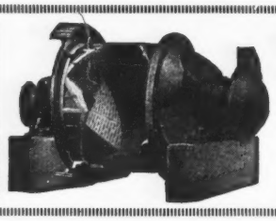

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Mead, H. L., Mining Engineer. American Cyanamid Co., 511 Fifth Ave., New York.

Miller, Thos. N., Mining Engineer, Tientsin, China. Cable: "Sams." Code: Bentleys. Examinations in Asia only.

Mills & Manning, Inc. Rm Chang Building, Rue Linevitch, Peking, China.

Minard, Frederick H., Mining Engineer. 41 East 42nd St., New York City. Tel.: Murray Hill 9076. Cable: Frednard. Code: McNeill.

Mineral Lands Financing Co., Silver-Lead-Gold-Copper-Zinc Mines Portland Canal Section, Cassiar Mining District, B. C., Copper Mines, Ariz., Home Office, Seattle, Wash.

Mitke, Charles A., Consulting Mining Engineer. Mine Examinations and Reports. Phoenix, Ariz.

Mudd, Harvey S., Mining Engineer, 1206 Pacific Mutual Bldg., Los Angeles, Cal. Cable Address: Selmud.

Munro, C. H., Mining Engineer. Hobart Bldg., San Francisco. • Cable: Ornum.

Munroe, H. S., Mining Engineer, c/o The American Metal Co., Ltd., 61 Broadway, New York.

N

Naething, Foster S., Consulting Mining Engineer, Joplin, Missouri.

Neill, James W., Mining Engineer and Metallurgist. 430 W. Colorado St., Pasadena, Cal. Cable: Jimusan Usual codes.

Notzan, Arthur, Mining Engineer and Geologist. Room 1410, 50 Broadway, New York City.

Nowland, Ralph C. Hobart Bldg., San Francisco. In charge Exploration Dept. of D. C. Jackling.

Nunn, R. K., Construction Engineer, Designs for concentrators, Industrial Plants, 602 Martin Bldg., El Paso, Tex.

P

Packard, George A., Mining Engineer and Metallurgist 50 Congress St., Boston, Mass. Cable Address: "Geopack." Boston.

Payne, Henry Mace, Consulting Mining Engineer. 841 Munsey Bldg., Washington, D. C. Cable Macepayne. Usual codes.

Perry, O. B., Mining Engineer. 216 Pacific Bldg., Vancouver, B. C., Canada.

Pickering, J. C., Mining Engineer, c/o Patino Mines & Enterprises, Consol., Llallagua, Bolivia, South America. Cables: Keringpic, Oruro, Bolivia.

Poillon & Poirier, Howard Poillon, C. H. Poirier, Mining Engineers. 11 Broadway, New York.

Prouty, Roswell W. Mining Engineer and Geologist. Specializes in Non Metallics. 1223 Pacific Nat'l Bank Bldg., Los Angeles, Calif.

R

Radiore Company, The. 1204 Hollingsworth Bldg., Los Angeles. H. E. Olund and A. B. Menefee. Mining Engineers. Radio-Electrical surveys for locating sulphide and other conductive ores. Mining examinations and reports.

Rakowsky, Victor. Engineer of mines in the development by explorations of the Oklahoma, Kansas, Missouri Zinc-Lead Fields, Joplin, Mo.

Reid, J. A., Mining Engineer and Geologist. 702 Northern Ontario Bldg., Toronto, Ont.

Richards Gragg, Mining Geologist. 609 West Johnson St., Madison, Wis.

Richards & Locke, Robt. H. Richards, Chas. E. Locke, Min. Engineers. Careful Concentration Tests for Design of Flow Sheets for Difficult Ores, 69 Mass. Ave., Cambridge A, Mass.

Ricketts, L. D., Consulting Engineer, 325 Pacific Southwest Bank Bldg., Pasadena, Cal.

Ritter, A. Etienne, Mining Engineer and Geologist. 408-9 Empire Building, Denver, Colo.

Robbins, P. A. 100 Prospect Ave., Highland Park, Ill. Telephone "Highland Park 529."

Roberts, Hugh M., Mining Geologist, 306 Lonsdale Bldg., Duluth, Minn.

Roberts, Milnor, Mining Engineer. The Pacific Northwest, British Columbia and Alaska. University Station, Seattle, Wash.

Rogers, Edwin M., Consulting Mining Engineer. Room 1012, 61 Broadway, New York.

Rogers, Mayer & Ball, Allen H. Rogers, Sydney H. Ball, Lucius W. Mayer, Mining Engineers. 26 Beaver St., New York. Cable: Alhasters.

Rosewater, W. M., Consulting Mechanical Eng., Specializing on design and construction of mining dredges. 1700 Keith Bldg., Cleveland.

Rutherford, Forest, Consulting Metallurgist. Ore Smelting Contracts, Investigated. Smelting and Milling of Copper and Lead Ores, Design and Construction. 50 Broad St., Room 1242, N. Y.

S

Saunders, T. Skewes, Mining Engineer. Examination, Consultation and Management. University Club, Bucarcli 35, Mex., D. F., Mex.

Sayre, Robert H., Mining Engineer. Berger & Sayre, 617 Majestic Bldg., Denver, Colo. Usual Codes.

Semple, C. Carleton, Mining Engineer and Metallurgist. Buenos Aires, South America.

Shaler, Millard K., Mining Geologist and Engineer. 40 Rue Royale, Brussels, Belgium. Cable Address: Milshaler, Bruxelles.

Sill, Rush. T., Consulting Engineer of Mines, 1219 Pacific Mutual Bldg., Los Angeles, Calif.

Simonds, F. M., Mining Engineer. 25 Madison Ave., New York.

Simpson, W. E., Mining Engineer. Swastika, Ontario, Canada. Cable: Simpson-Swastika.

Spearman, Chas., B. Sc., M. A., Consulting Mining Geologist and Engineer. Examinations, reports, etc. Exploration and mining programs. Milling and mill construction. Room 704, Power Bldg., Montreal, Quebec.

Spurr, J. E., Research in Mining Geology. Home Address: 7 Edgewood Park, New Rochelle, N. Y.

Stebbins, Elwyn W., Mining and Metallurgical Engineer. 814 Mills Bldg., San Francisco.

Steele, Heath, Mining Engineer. The American Metal Co., Ltd., 61 Broadway, New York City.

Sterrett, Douglas B., Geologist. Mining and Petroleum. Springland, Pierce Hill Road, Washington, D. C.

Stevens, Frank G. Mining Engineer. 36 Oakmount Road, Toronto, Canada.

Stewart, R. H., Mining and Metallurgical Engineer. Vancouver Block, Vancouver, B. C.

Strauss, Lester W., Engineer of Mines 611 West 114th St., New York City. Code: McNeill.

Summerhayes, Maurice W., Mining Engineer. Examinations. Diamond Drill Programs. Development and Management of Properties. Confederation Life Bldg., Toronto Canada.

Sussman, Otto, Ph.D., Mining Engineer. 61 Broadway, New York.

T

Thomas Kirby, Consulting Engineer, Examinations and Negotiations, Mines, Oil and Natural Resource Properties, 25 Broadway, N. Y. City.

Thorne, W. E., Mining Engineer. Anori, Antioquia, Colombia. McNeill 1908 Code.

Thornhill and Anderson, Engineers. West Allis Wis., care Allis-Chalmers Mfg. Co. E. B. Thornhill and H. G. S. Anderson. Cable Address: Spongeiron Milwaukee.

Titcomb, Harold A., Mining Engineer, Selection Trust Bldg., Masons Avenue, London, E. C. 2.

Turner, J. K., Mining Engineer. Goldfield Nevada, and Loew's State Bldg., Los Angeles, Cal.

Tyrrell, J. B., Mining Engineer and Geologist. 810 Lumsden Building, Toronto, Canada.

V

Van Wagenen, Hugh R., Mining Engineer, 607 Van Nuys Bldg., Los Angeles, Calif. Cable address: Vanwagenen. Code: Bedford-McNeill.

Varley, Thomas, Consulting Metallurgist. Technical Specialty, Concentration of Ores. Office and Laboratories, 453 Tenth East Street, Salt Lake City, Utah.

W

Wallace, Louis R., Mining and Metallurgical Engineer. Forwarding Address: Rancho Santa Fe, California. Bentley's Code.

Ward, William F., Mining Engineer, c/o Julio Racines, Buenaventura, Colombia, South America.

Weekes, Frederic R., Consult. Mining Engr. The Porcupine Goldfields, Development and Finance Co., Ltd., 407 Canada Cement Co. Bldg., Philips Sq., Montreal, Que.

Westervelt, William Young, Consulting Mining Engineer. 522 Fifth Ave., New York Cable: Casewest. Code: Broomhall's.

Wheeler, H. A., Mining Engineer. Reports on Oil and Mining Properties. 900 Security Bldg., St. Louis, Mo. Cable: "Wah." St. Louis.

Whitaker & Schlereth, O. R. Whitaker, C. G. Schlereth, Mining Engineers, 932 Equitable Bldg., Denver, Colo., 25 Broad St., New York.

White, E. F., Con. M.E., Sulfur Plants, 50 Maple St., Rutherford, N. J. Ore smelting, new process superfine dusting sulphur, no grinding.

White, J. E., Consulting Engineer. 1028 State St., Santa Barbara, California.

Whitman, Alfred R., Consulting Geologist. Exploration, underground and general. Univ. of Cal. at Los Angeles, Cal.

Witherell, Charles S., Metallurgical Engineer 150 Nassau St., N. Y. Cable: "Metwith." Phone Beekman 4957.

Wolf, Harry J., Mining Engineer, 42 Broadway New York. Cable: Minewolf. Codes: Bedford-McNeill.

Wyman, Henry, Consulting Metallurgist Asientos, Aguascalientes, Mexico.

Y

Yeatman & Berry, Pope Yeatman, Edwin S. Berry, Consulting Mining Engineers. Examination, Development and Management of Properties. Room 2030 165 Broadway, New York. Cable: Ikona. Code: Bedford-McNeill

Z

Zalinski, Edward R., Mining Engineer. 524 Newhouse Bldg., Salt Lake City. Examination Geological Mapping Development.

Zentner, Arthur A. Consulting Research and Metallurgical Engineer, Electrolytic Zinc Complex Ores, 74 New Montgomery St., San Francisco.

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A

Arizona Assay Office, Chas. A. Diehl, Custom and Consulting Assayer, Chemist, 315 N. First St., Box 1148, Phoenix, Ariz.

Atkin & McRae, Assayers, Chemists and Metallurgists, Control and Umpire Assays, Flotation and Cyanide Tests. 747 S. Hill St., Los Angeles, Cal.

B

Bardwell, Alonzo F., Custom Assayer and Chemist, 158 S. W. Temple St., Salt Lake City, Utah. Ore Shippers' Agent.

Baverstock & Payne, Industrial Chemists and Assayers. Technical and Chemical Analysis of Ores, Minerals and all Organic Materials. 552 So. Figueroa St. Los Angeles, Cal.

Black & Deason, Assayers and Chemists. 165 South West Temple St., Salt Lake City, Utah.

Burlingame, & Parker, Est. 1866, Assayers and Chemists, Ore Shippers' Agent. Testing Laboratory, 1915 Lawrence St., Denver, Colo.

C

Critchett & Ferguson, Assayers and Chemists. El Paso, Texas. Umpire and Controls a Specialty.

E

Ely, E. Prop. Dover Laboratory, Analysts, Assayers. Reports, Gold Assay, $2.00; Iron det. $1.00; Phos., $1.50. Dover, N. J.

F

Frost, Oscar J., Assayer and Chemist. 1310-12 17th Ave. P. O. Box 145, Denver, Colo.

G

Gibson, Walter L., Successor to Falkenau Assaying Co. Assay Office and Analytical Laboratory, School of Assaying. 824 Washington St., Oakland, Cal. Phone Glencourt 672. Umpire assays and supervision of sampling. Working tests of ores, analysis. Investigations of metallurgical and technical processes.

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Goodall Bros., Archie J. Goodall, Assayer and Chemist; H. H. Mayer, Mining Engineer. Customs Assayers, Examinations and Reports, Ore Testing, Shipper's Representatives. Control and Umpire Work a Specialty. Helena, Montana.

H

Hanks, Abbot A., Inc., Chemists and Assayers. 624 Sacramento St., San Francisco, Calif. Control and Umpire Assays, Supervision of Sampling at Smelters. Inspection and Testing of building materials.

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Hawley & Hawley, Assayers, Chemists, Ore Buyers, Shippers' Representatives. Box 151, Douglas, Ariz.

L

Laucks Laboratories Inc., Chemists, Assayers, Metallurgists, Ore Testing, Umpire Sampling Import & Export Ore Shipments, 314 Maritime Bldg., Seattle, Wash.

Ledoux & Co., Inc., Assayers, Chemists and Metallurgists. Independent Samplers at the Port of New York. Representatives at all Refineries and Smelters on Atlantic Seaboard. Office and Laboratory, 99 John St., New York.

Luckhardt Co., C. A., Assayors, Chemists, Metallurgists, Research and Chemical Engineers, Independent ore Samplers. 627 Commercial St., San Francisco, Cal.

M

Moore, Geo. A. & Co., Assayers and Chemists, 212 California St., San Francisco. Control and Umpire Assays, Complete Ore Testing Laboratory, 615 University Ave., Berkeley, Calif.

O

Officer & Co., R. H., Ore Shippers' Service. Engineers' Assays, Controls, Umpires Iron and Steel, Oil and Coal Analyses. 169 S. W. Temple St., Salt Lake City, Utah.

P

Physical Exploration Corp., 111 Broadway, New York, and 1865 Monroe St., Madison, Wisc. Electrical and physical methods for exploration of ore-deposits. Technical direction: Mason, Slichter & Hay.

Piers, W. L., Assayer and Chemist. Rare Metals and Analyses. 1736 Glenarm St., Denver, Colo.

Pitkin, Inc., Lucius, Weighers, Samplers and Assayers of Ores of all Descriptions. 47 Fulton St., New York. Cable: Piktip.

R

Richards & Locke. See Professional Directory.

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Root & Simpson, Successors to Leonard & Root, established 1902. Assayers and Metallurgical Chemists. 1744 Broadway, Denver, Colo.

S

Schlumberger Electrical Prospecting Methods, 62 Front St. W., Toronto 2, Ont. Telegr. "Elecpropec". Tel. Main 1870.

Sill, Harley A., Consulting Engineer. 1011 South Figueroa St., Los Angeles. Examinations, Management, Geology, Ore Testing, Research, Mill Design. Consulting Engineers and Managers for Mining and Milling Operations. Metallurgical Plant equipped for large scale test work.

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T

Taumac Corp., The. 342 Madison Ave., New York City. Electric and Electromagnetic Surveys. Cable address: Taumacorp.

U

Union Assay Office, Inc., Assayers and Chemists Box 1446, Salt Lake City, Utah.

W

Waring & Williams, Industrial and Analytical Chemists. Analyses, Tests, Metals, Ores, Zinc-Lead Reports. Joplin, Mo.

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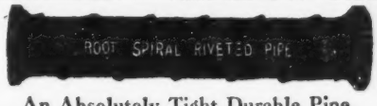

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18—Deister-Plato Concentration Tables, 12 driven by 2 hp., 1,200 r.p.m. Motors, back geared to the Head motions. 6 same as above except they are belt driven.

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2—8-ft. type, 37 Hummers, 2-surface with 1 G4 Generator set.

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1—Dorr thickener, 54-ft.x14-ft., with tank.

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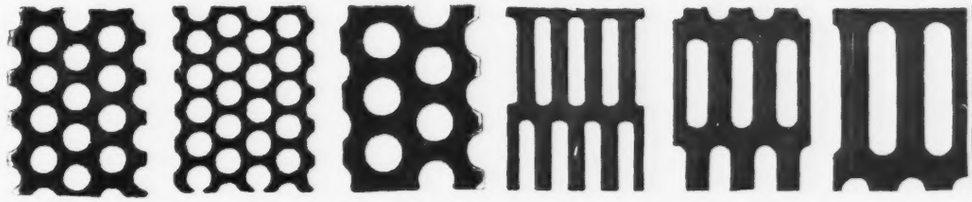

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Shaft Sinking
Longyear Co., E. J.

Sharpeners, Drill
Gardner-Denver Co.
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Sullivan Machinery Co.

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Myers Whaley Co.

Shoveling Machines
Myers Whaley Co.

Sintering Apparatus
Dwight & Lloyd Sintering Co.

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Atlas Car & Mfg. Co.
Wellman-Seaver-Morgan Co.

Smelters
Amer. Smeltg. & Refg. Co.
International Smelting Co.
Matthiessen & Hegeler Zinc Co.
Nichols Copper Co.
U. S. Smelting, Refining & Mining Co.

Sodium Sulphate
Barium Products Inc.

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Speed Regulators, Controllers, Motor
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American Metal Co.
Amer. Smltg. & Refg. Co.

Starters, Motor
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Steel, Drill
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Midvale Co., The
Ziv Steel & Wire Co.

Steel Drill, Hollow & Solid
Ziv Steel & Wire Co.

Steel, Manganese
Midvale Co., The

Stokers, Hand
Combustion Eng'r'g Corp.

Stokers, Mechanical
Combustion Eng'r'g Corp.

Structural Steel
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Galigher Co.

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Hardinge Co.
Thyle Machinery Co.
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Armstrong Mfg. Co.

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A.
Roebling's Sons Co., J. A.

Transformers, Electric
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Lunkenheimer Co., The

Valves, Check
Lunkenheimer Co., The

Valves, Gate
Lunkenheimer Co., The

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Lunkenheimer Co., The

Valves, Non-Return
Lunkenheimer Co., The

Valves, Pop Safety
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General Electric Co.

Valves, Water Rock Drill
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Watt Car and Wheel Co.

Wheels, Car
Watt Car & Wheel Co.

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Lunkenheimer Co., The

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International Ore & Smelting Co.

Zinc Dust
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Amer. Smeltg. & Refg. Co.
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Zinc Oxide
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Zinc, Sheet
Matthiessen & Hegeler Zinc Co.

Zinc Sulphate
Amer. Smeltg. & Refg. Co.
Machinery Sales Agency

A Personal Want—

can invariably be filled by a friend.

The Searchlight Section

of this issue covers the current business wants of the industries in which this paper is read.

For Every Business Want

"Think SEARCHLIGHT *First"*

A Business Want—

must be satisfied by someone in your industry.

0134

Dorrco Doings in 1927

THE year just closed has been one of tightening competition with lesser margins in most lines, and a disappointment to many in the total business done. In Europe it has seen the formation of an international chemical cartel as the result of the apparent success of the steel combination and a general preparation for intensive work with a lessening of uneconomic competition and a pooling of knowledge and experience in certain lines.

Although during most of the year a note of uncertainty was heard, the stock market showed confidence in the future and at the close of the year pointed towards prosperity in 1928.

Our own year has been one of better coordination with many minor advances made and several major developments that should make their contributions to the industries which we serve during the coming year. As our work has developed in different fields it has sometimes seemed as if we were spreading "too thin," and would have difficulty in really grasping the problems to be met in so many varied industries. Experience has shown, however, that our real opportunities have been greater because of it. A recent advance in Sanitary Engineering, for instance, was made possible by the use of our specialized knowledge gained in metallurgical work.

SERVICE—The service work of the Company, including supervision of installation, inspection, initial operation, and adjustment of our equipment, as well as the "trouble shooting" that inevitably arises from time to time, has now been centralized in a Service Division of our Engineering Department. This means complete coordination from the placing of the order until the new equipment is finally adjusted and running smoothly, and the operators are well trained.

THE DORRCO FILTER—As a result of a careful study extending over more than a year, we have introduced a new and distinctive type of continuous rotary vacuum filter for general filtration work. Certain features of this machine give it a somewhat broader field of utility than is generally assigned to vacuum filtration of finely divided solids.

CLOSED CIRCUIT GRINDING—Finer grinding generally required by selective flotation has called for improvment in grinding efficiency and has resulted in higher circulating loads and larger classifying units. At one plant 42 Model C Classifiers which have served well for ten years, are being replaced by new, very heavy type Model D's. Closed Circuit Grinding in primary as well as secondary circuits keeps advancing, with the Bowl Classifier in greater demand, and one cyanide mill doing all its agitation before final overflow.

The great progress made in automatic regulation of complicated manufacturing processes has made automatic feed regulation for closed circuit grinding appear an easy step. We have been working at it for a long time and believe we have now developed a control that will regulate conditions of feed or product and give the greatest grinding efficiency under widely varying conditions.

BEET SUGAR—Research and development work over several seasons has enabled us to perfect a process for making first carbonation automatically continuous and giving a controlled product of uniform quick-settling and filtering properties.

THE DORRCO SAND WASHER—The "age of concrete" has required enormous quantities of sand and gravel, produced to rigid specifications. Our contribution has been the Dorrco Sand Washer used on dredges and stationary plants and washing as much as 150 tons of sand per hour.

THE LIMIT!—When we built a Dorr Thickener 200′ in diameter some years ago it seemed very large. We have built many since, but this year our friends of the Miami Copper, where records in other lines have also been broken, have asked us to build a 325′ Thickener to dewater 16,000 tons of tailings per day. Our engineering Department say they will go further if asked.

SANITARY ENGINEERING—Sewage Treatment continues to make rapid progress, hastened by the realization that continuous mechanical operations can replace batch treatment and hand labor.

The Dorrco Bar Screen is now being installed at the world's largest sewage plant in Chicago — another unit operation mechanicalized.

An investigation covering the past year has resulted in the development of equipment for the continuous removal of clean grit or fine sand from sewage, before treatment. This avoids the periodical interruption of operation of grit chambers for the removal of accumulated solids.

Our new Square Traction Clarifier is being widely installed for sedimentation in both sewage and water works. After thorough experimentation it was adopted by St. Louis to remove the silt from Missouri River water both before and after treatment with chemicals. Four 150′ units are now under construction.

Separate sludge digestion has been adopted for the majority of installations contracted for in 1927. One of the largest plants of this type, put into operation this year at Sioux Falls, S. D., includes Dorr Clarifiers and the new type of Dorr Digester, which utilizes the gas generated by digestion to maintain the optimum temperature for the bacterial activity desired. In warmer climates the gas is available for power and lighting.

Our new Impeller Agitator, for thorough but gentle mixing to assist in floc formation, saved 45.5% of the chemicals required in one water treatment plant.

FOREIGN—We have in our New York office a four-foot globe and we take great pride in its varicolored pins showing installations all over the world in different industries. Our European associates have added many during the past year. They represent, among others, causticizing in the biggest paper mill in Europe, metallurgy in the Polish mine operated so well by Anaconda, chemical plants in Germany, sewage treatment in France and Germany, while a red pin stands for the biggest leaching plant in Africa.

Our Mr. Spicer is headed for Australia and the East. When he made the same trip in 1911 it meant that one-fifth of the staff had gone.

Time has brought many changes but we feel that the best it has given us is those friends scattered over the mining camps of the world, and in more recent years through industrial plants as well, who have helped us by kindly criticisms and suggestions to develop our work. It might interest them to know that our statistician claims that over 95% of the gold and silver, over 90% of the lead and copper, 85% of the zinc and 100% of the aluminum produced in North America comes into contact with our equipment.

We cannot see the future, but if a loyal body of workers means anything, I can assure our friends that we shall go forward as in the past, proud of what we can contribute to the world of industry.

John V. N. Dorr

247 Park Avenue New York City

DORRCO

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This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Engineering and Mining Journal* assumes no responsibility for errors or omissions.

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Continuous discharge of a uniform size of product

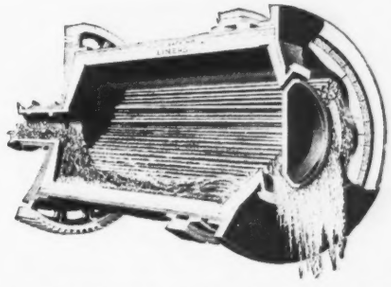
The patented sloping heads of the Marcy Open End Rod Mill contribute greatly to its success.

These sloping mill ends push back the rods into proper position and prevent the rods from binding on their ends. Wear on end liners is minimized.

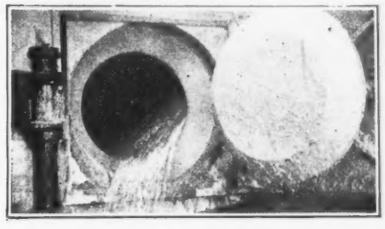
The space between the ends of the rods and the ends of the mill barrel provide a pocket into which incoming feed can fall without interfering with the free rolling action or line contact of the rods.

Finished pulp flows freely and rapidly from the ends of the rods and falls directly out of the patented Open Discharge End.

(Ask any Marcy Operator)



Sectional view of the Marcy Open End Rod Mill. Note the sloping ends of the mill barrel.

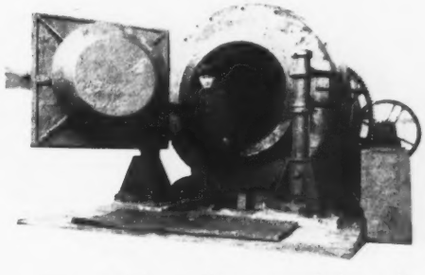


Photograph of a revolving Marcy Rod Mill. Whether the door is open or closed, the ground material is permitted to flow freely through the large discharge end. The door can be opened while mill is in operation, as rods will not work out. You can see what is taking place within a Marcy Rod Mill, and thus maintain the grinding medium at the highest point of efficiency.

MARCY ROD MILLS ARE MADE IN THREE STYLES, THE MAIN DIFFERENCE BEING IN THE WAY THE MILL BARREL IS CARRIED.

SIZES IN FEET

1x2	3x6	4x8	5x10	6x12
2x4	3x8	4x10	5x12	7x15



The world's leading ore grinder. It utilizes the Marcy grinding principles to the fullest extent and has revived the interest of metallurgists in the known but hitherto undeveloped possibilities of rod grinding.

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CHEMICALS

PERFORMANCE

Strong at the Finish

Jumping on a stuck steel left by another drill, The Cleveland D5 Drifter put down six holes 27 feet to 35 feet deep on a prospecting job. And—"The D5 seemed as powerful at the bottom of the hole as at the start."

That's what you're interested in. Let's demonstrate on your property. Say when.

THE CLEVELAND ROCK DRILL CO.
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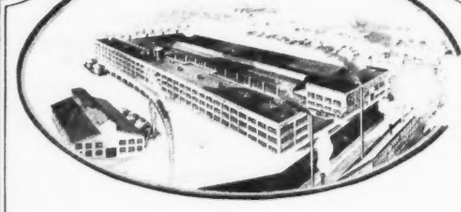

The Plant
Back of the Performance

This bird's-eye view shows the group of Spacious fireproof buildings that house the organization of skilled engineers and mechanics who design and make Cleveland drills.

CLEVELAND ROCK DRILLS